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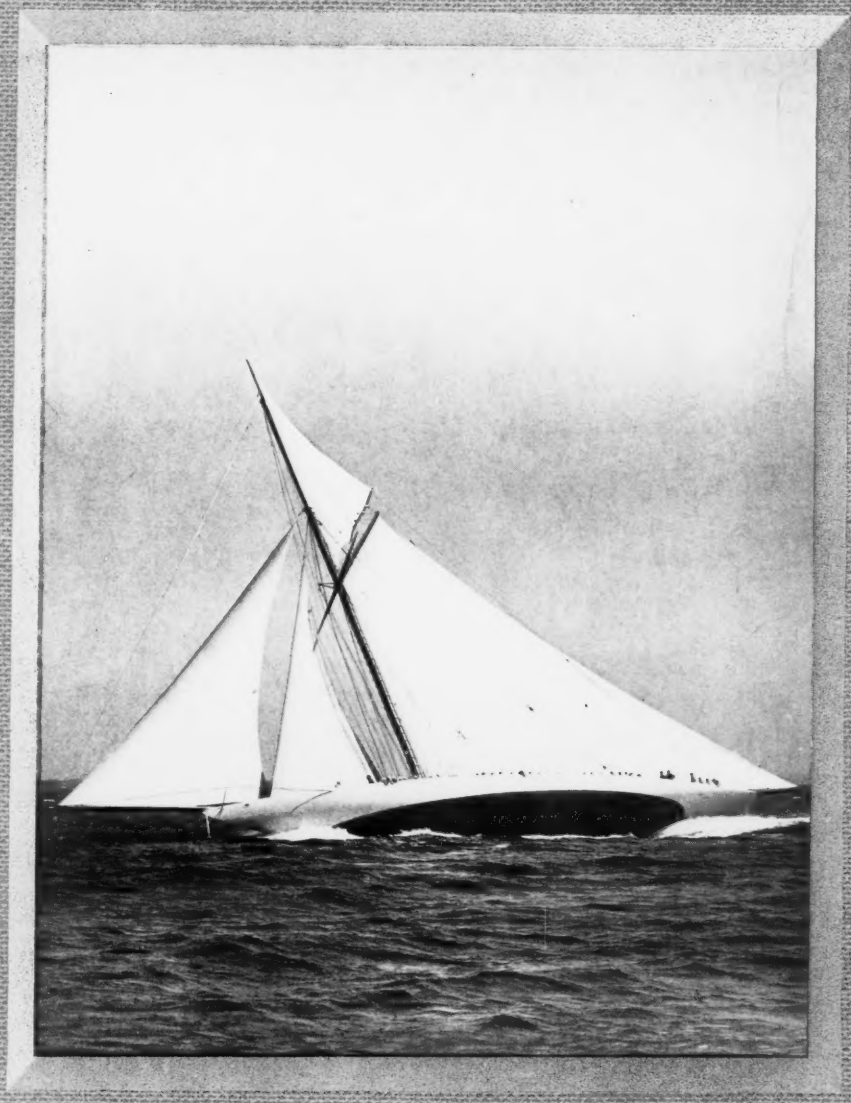

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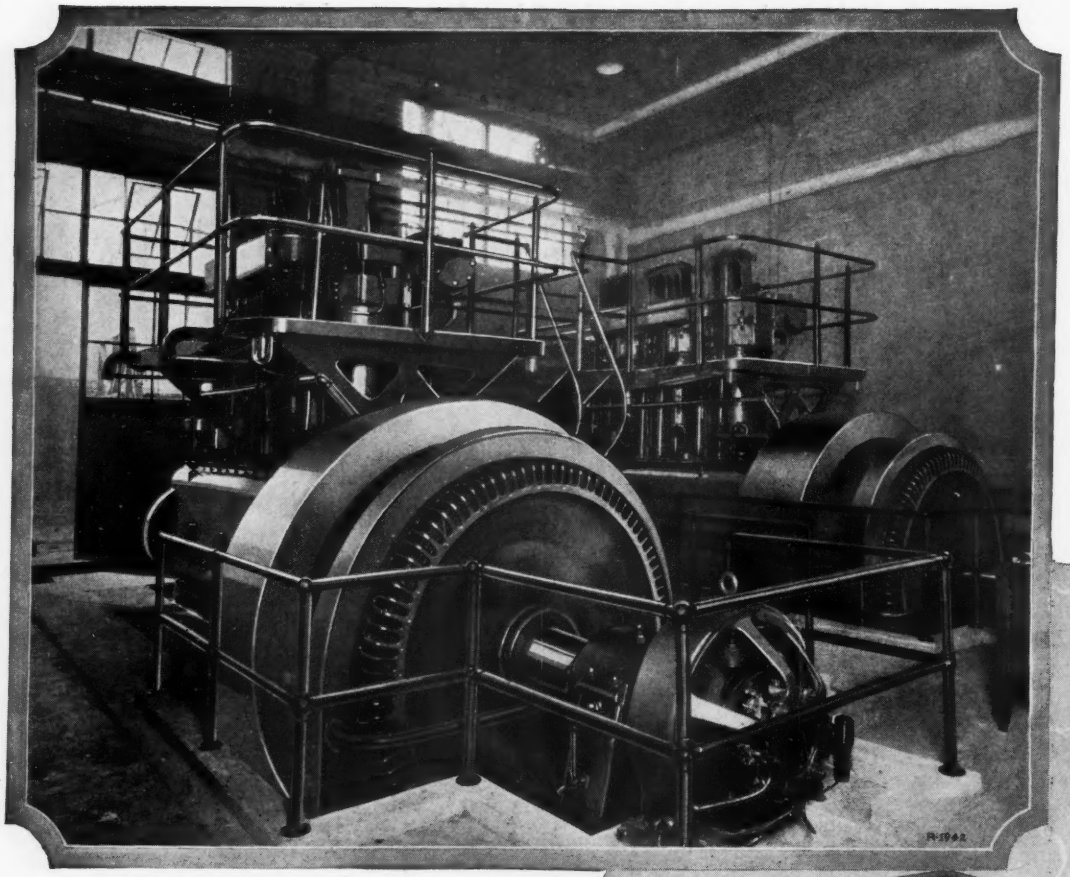

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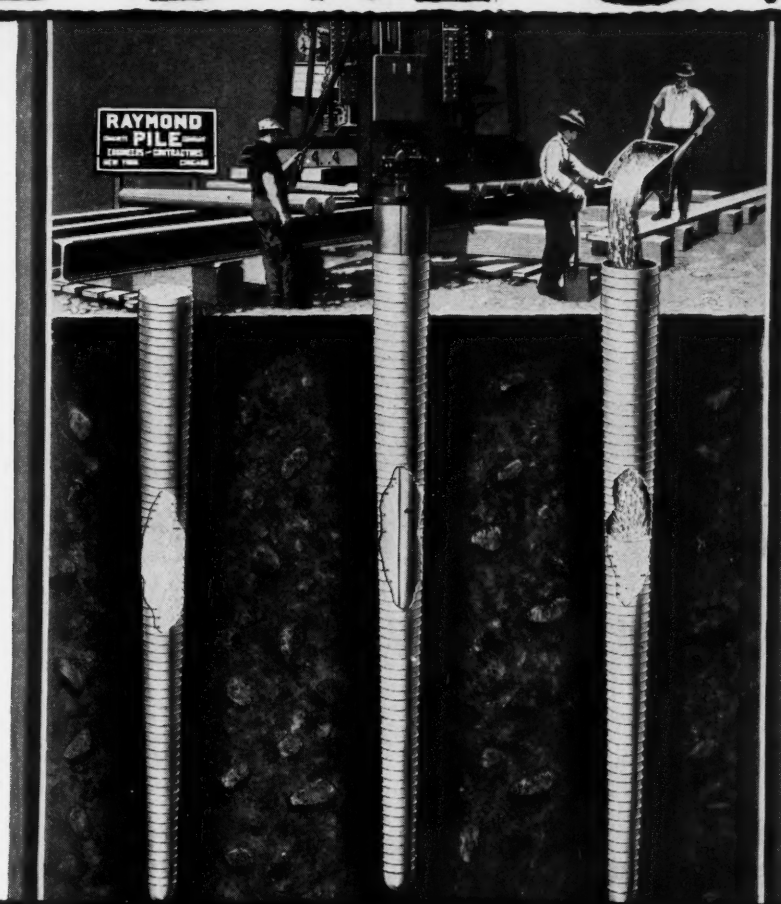

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Among Our Authors

RICHARD H. FRAZIER, of the Department of Electrical Engineering and author of the article on Honors Groups, is a graduate of the Institute in the class of 1923. Upon graduation he joined the Railway and Industrial Engineering Company with which he stayed several years designing high tension outdoor sub-station equipment. Since 1925 he has been on the staff of the Department of Electrical Engineering, chiefly interested in the development of the Honors Group plan. His summers are usually spent with such corporations as Stone and Webster and the Western Electric Company.

AMONG the foremost ordnance engineers of the world is Major Gladeon M. Barnes, at present connected with the Watertown Arsenal. Major Barnes graduated from the University of Michigan in 1910, with the degree of Civil Engineer. In the fall of the same year he was commissioned in the Coast Artillery Corps. However, a special aptitude for development work led to his transfer to the Ordnance division. In this work he has been conspicuously successful.

During the World War, Major Barnes held a temporary commission of Lieutenant-Colonel, and worked principally on the development of railway artillery. Since then, seacoast and anti-aircraft artillery have held his attention. He has visited officially all the principal arsenals and ordnance establishments in Europe.

"THE Engineer and the Stock Market" are known to be very closely related in many ways, but the development of the stock ticker is the one way which Mr. E. R. Wheeler '17 treats at some length in his article of the above title. After graduating in the Electrical Engineering Course, he went in to the Engineering Department of the Western Union Telegraph Company. For two years he was engaged in development and field experimental work on ocean cable printers. Since then he has been in direct charge of the group engaged in development, design, and initial field operation of ticker systems and equipment.

A NON-TECHNICAL article in the form of a survey of the coming America's Cup Race, the yachting classic, is presented by Professor George Owen '94. A graduate of the Mechanical Engineering Course, he went to work in the Herreshoff shops, well-known yacht designing and construction firm. After his training there he went into Naval Architecture for himself. In 1916, when the Course in Naval Architecture was reorganized, he returned to the Institute as an Assistant Professor. We feel that he is very well qualified to present this subject as he is the designer of the *Defiance*, one of the defenders which was built for the last race for the America's cup.

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THE TECH ENGINEERING NEWS

THE PROFESSIONAL JOURNAL OF THE UNDERGRADUATES OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

VOLUME XI APRIL, 1930 NUMBER 3

THE HONORS GROUP PLAN

How the Department of Electrical Engineering provides for students of different mental speeds and capacities

By RICHARD H. FRAZIER '23

Department of Electrical Engineering
Massachusetts Institute of Technology

SEVERAL years ago some of the students at this institution originated an inquiry into the methods used in certain subjects of instruction in hope of securing desired changes. Recommendations were made to the faculty through a committee authorized for the purpose by the student governing body, the Institute Committee. In turn, a committee of the faculty received these recommendations, and after due consideration accepted a number of them and gave reasons for the rejection of others. Some of the recommendations, of course, were rather near-sighted, but on the whole the interest taken by the students in seeking the reasons for being subjected to certain processes was a healthy sign, further symptoms of which continued to appear in the editorial column and the Open Forum of *The Tech* for some time. While the judgment of old graduates is apt to be more mature and more sound than the judgment of young graduates or of students, the criticisms of the older men usually are directed at things as they knew them twenty-five or thirty years ago, now non-existent. The object of the present discussion, therefore, is not only to explain some of the educational processes employed in this Department but also to solicit coöperation for improvement of them.

The problem of evolving effective educational methods is an exceedingly difficult one, for it is difficult to reach agreement upon or even to define the aims which education should have; to ascertain to what extent these aims have been reached, and to determine wherein the educational processes employed have contributed towards ultimate attainment. That is, after establishing an educational scheme supposedly sound in theory, one must wait half a lifetime or more in order to observe results, and in the meanwhile so many other influences have entered that it is well-nigh impossible to assign to formal education its proper weight. So in debating these matters one often is apt to take advantage of a position similar to the one which Wordsworth gives to the parson:

"In arguing, too, the parson owned his skill,
For e'en though vanquished, he could argue still."

Naturally every educational institution takes pride in and likes to claim a certain amount of credit for the worthwhile accomplishments of its former students. But when the general public interests itself in allocating academic honors, the credit or blame for whatever influences may have worked towards the production of a distinguished scholar or a distinguished scoundrel usually accumulates to the institution of learning last attended by the particular hero. Now the period of study for the bachelor's degree ordinarily consumes but four years of the proverbial threescore and ten and is so situated that it must use as a foundation some eighteen years of previous home influence, primary and secondary education. To expect an institution of higher education to take young men in their late 'teens and supply them for four years with an environment of such profound influence as would justify the acceptance of responsibility for all future acts is to expect a great deal indeed, and needless to say no honest educators are so optimistic. Yet, it is well for students to bear in mind that in the future, particularly if they live in communities in which they were previously unknown, a rather disproportionate share of the credit or blame concerning not only professional matters but also matters of everyday living, may be reflected upon the institution claimed as alma mater. Or, to illustrate from a case near at hand, when students who have spent a month or two at the Massachusetts Institute

(*Continued on page 100*)

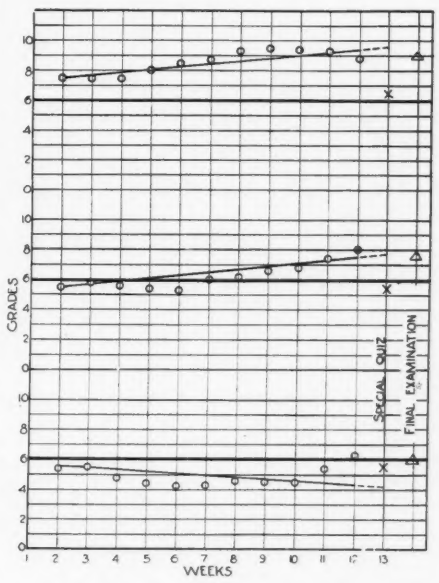
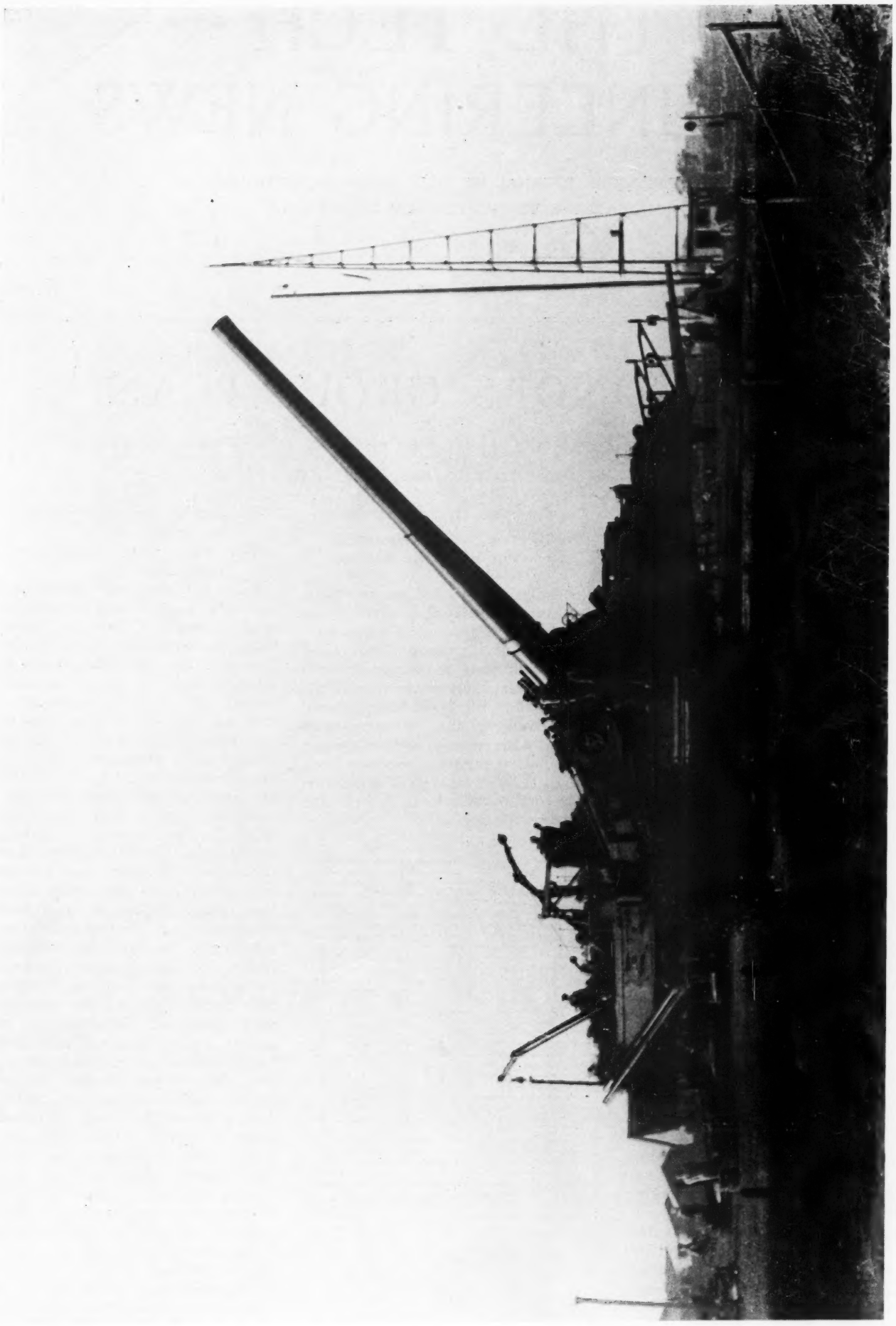


FIG. 1

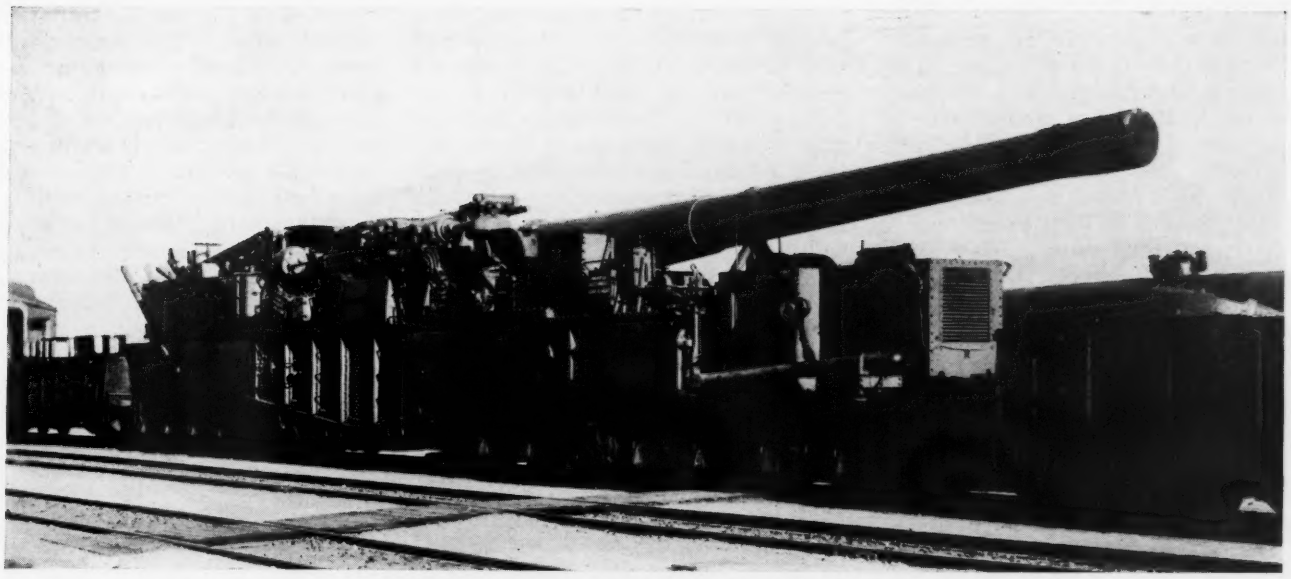
Average problem section records made by students grouped according to mental speeds in the Department of Electrical Engineering.

* Mostly a lecture to the sophomore class in Electrical Engineering, March 7, 1930.



LATEST COAST DEFENSE GUN

This railway carriage was recently developed for mounting major calibre guns or howitzers.



12-INCH HOWITZER RAILWAY CARRIAGE, 1918
This mount is so designed that the howitzer can be fired quickly from the track at all angles of traverse.

Big Guns*

14- and 16-inch guns on mobile units provide adequate defense for our many miles of coast line

By GLADEON M. BARNES
Major, Ordnance Division, United States Army
Watertown Arsenal

ARTILLERY authorities have always maintained that battleships cannot successfully attack land fortifications. This contention was strengthened during the World War by the results of the combined British and French attacks upon the Turkish coast defenses at Dardenelles and upon the German defenses along the Belgium coast. The strong resistance made by the old Turkish forts at the Dardenelles furnishes an excellent example of the power of the land fortifications over ships at sea. The land batteries, with the exception of a few at the entrance of the Narrows, although under the terrific fire of the combined fleets, were not silenced. At the entrance, the old guns were many times outranged, but the ships had plenty of sea in which to maneuver, and could bring their heavy guns to bear. The Turkish short range guns in this case could not reply. When, however, the allied ships attempted to enter the Narrows, they came within range of the shore batteries and entered an area in which fixed and floating mines had been laid. The Allied losses then became so heavy that it was necessary for them to retire and abandon the attack.

The German defenses, hastily erected along the Belgian coast were constantly shelled by the heavy guns of the Allied monitors. The positions of the German guns were accurately known, as Allied aviators had photographed them. These aviators dropped a large number of bombs upon the German batteries, but there is no evidence that any of the German guns were ever hit or damaged by shell fire from ships or by bombs dropped from aeroplanes.

In brief, the World War again conclusively demonstrated that battleships cannot hope to successfully attack land fortifications if the land guns range with those on the ships.

IN the World War, railway artillery was employed more extensively than ever before, and as the war continued guns of the largest calibers were mounted on railway carriages which permitted them not only to be moved from place to place, but to be fired directly from the carriages. When the war became stabilized and both sides were established in trenches, it was impossible to reach very far behind the enemy lines, using the ordinary field guns. Airplanes could, of course, fly over the lines and search out vital enemy points, but it was always uncertain as to how much damage could be accomplished by such raids, as the airplanes were constantly subjected to attacks by the enemy airplanes and ground guns. Important vital points such as concentration centers, ammunition dumps, cities, railway centers and bridges, were usually adequately defended by air and anti-aircraft forces. In order to reach far behind the enemy lines, guns of the greatest calibers, firing huge projectiles, were mounted on special railway carriages. Cities or strategic points which could be brought within the range of such guns were quickly destroyed. Even underground magazines sunk 20 to 40 feet below the ground were not safe from these guns which, with their plunging fire and delay fuses, could readily destroy such magazines, when located. The gun which gave the world the greatest thrill during the World War was the German long-range Bertha which fired upon Paris. This gun was able to place its projectiles within the City of Paris from a range of 76 miles. In order to obtain this great range it was necessary for the Germans to reduce the weight of the projectile to 320 pounds. However, even with this weight of projectile the gun caused more damage to the City of Paris than all the air raids combined. The fact that the guns were fired at uniform intervals demoralized the citizens, and although very little was said about this during the war, the German gun, nevertheless, brought practically all business within the City of Paris to a standstill and drove over a million people to other parts of the country. There is no

*Cuts obtained through courtesy of *Army Ordnance*.

question that a few more of such guns would have caused the abandonment of Paris as the capital of France. This German long-range gun was a railway gun. In fact, it was constructed by using one of the German 380 mm. (or 14.96 inch) railway guns and retubing to a smaller caliber, thus making possible a very great muzzle velocity and long range. Many railway mounts of calibers from 8 to 16 inches were built in this country during the World War, and these were rapidly arriving in France by the time of the Armistice. They would have played a prominent role in the great attacks which were planned for the ever-increasing American armies in France in the fall of 1918.

Post War Development in Railway Artillery

AFTER the World War a very thorough study was made of the railway artillery which had been built and developed by all countries during the World War. It was decided that, in building new railway artillery, the mounts should not only be capable of being used to accompany armies in the field, but should be so constructed that the guns could be used as seacoast guns to defend our coasts against attacks by naval vessels and landing parties from naval forces. This requirement brought about the design of dual purpose mounts so constructed that the guns could be fired from the railway tracks on their wheels with minimum of ground preparation. Furthermore, they could be dismounted from their wheels and placed over a prepared concrete foundation, and used for firing, like other fixed seacoast guns, at moving naval targets.

As a result of this program two railway carriages have been developed: one for mounting medium caliber guns or howitzers; the other for mounting major caliber guns or howitzers, which will fulfill all missions required of this type of artillery. The smaller railway mount can be used for either the 8-inch high-power gun or the 12-inch howitzer. The 8-inch high-power gun will throw a 300-lb. projectile 35,000 yards, and can successfully combat the latest types of fast cruisers. The gun would also be very effective against naval forces attempting to land in small boats. The 12-inch howitzer will fire a projectile weighing 700 lbs., and will give a maximum range of 22,000 yards. This howitzer could be effectively used against the largest battleships within its range and would also be a very destructive weapon when used against land fortifications. The railway mounting is so designed that the gun or howitzer can be fired quickly from the track at all angles of traverse (through 360 degrees). No concrete platform is required for this railway mount. It can be placed in the firing position by a trained crew in less than one-half hour. Before firing it is necessary to raise the carriage about 1 inch by means of special built-in jacks and to place two short I-beams under the girders parallel to the tracks. It is then lowered to rest upon this platform, which consists of the two I-beams, the railroad ties and roadbed. The outriggers, attached to the carriage, are then set against wooden floats buried in the ground. These prevent the carriage from moving horizontally. Although the unit is hand-maneuvered throughout, the rate of fire is about one shot every 50 seconds. This carriage is equally suitable for use with a field army against stationary targets or for seacoast defense work, against moving naval targets.

THE large railway mount permits either the high-power 14-inch gun or the 16-inch howitzer to be mounted interchangeably. The gun has a maximum elevation of 50 degrees, which will give a corresponding range of about 40,000 yards with a 1560-lb. armor-piercing projectile. For use against land targets it is possible to go into position in less than one hour, since no special foundation is needed. To prepare the mount for firing from the tracks it is raised by screw-jacks built into the girders until I-beams can be placed under each girder, as is done in the case of the 12-inch, 20-caliber howitzer railway mount previously described. It is prevented from moving to the rear by means of outriggers. By moving the top carriage upon the girders, seven degrees traverse of the gun can be obtained for the adjustment of fire. It will also be possible to run the mount over a simple concrete emplacement, bolt it down and obtain 360 degrees traverse. For this purpose the carriage is provided with a large ball-bearing attached to the lower side of the girder at the center.

14-INCH GUN ON RAILWAY MOUNT AT 50° ELEVATION
At this elevation it will have a range of 40,000 yards with a 1560-lb. armor-piercing projectile.

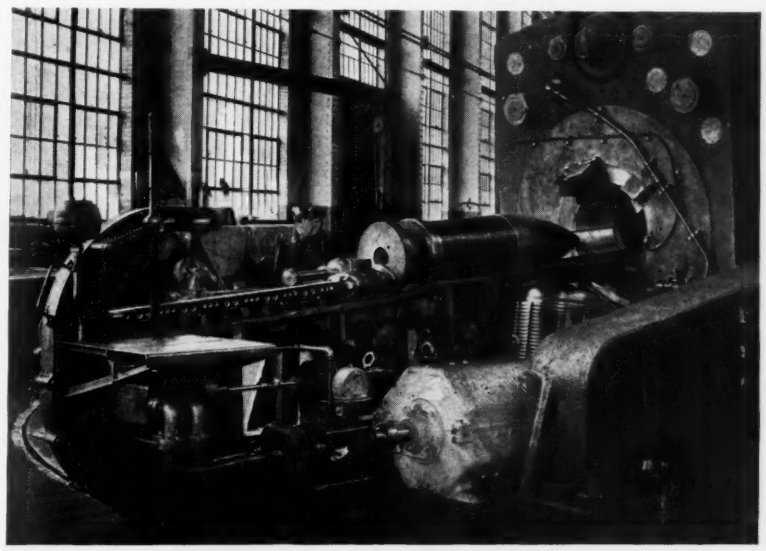
Two small wheels are located just in front of the rear trucks. After the ball-bearing is bolted to the concrete and the trucks have been removed, the mount can be turned in any direction by means of the two wheels which bear on steel segments buried in the concrete. In this position it is equivalent to any fixed carriage for coast defense work. A structural steel field platform permitting 360 degrees traverse has also been designed to enable the mount to be installed for all-around fire without the use of concrete.

The carriage is provided with full electrical equipment for electric firing, lighting, elevating, traversing, and loading the projectiles and powder. Current is furnished by a 25-kilowatt gasoline electric generator set located upon the front trucks of the mount. In fact the mount forms a complete travelling fort. The design permits the 14-inch gun and its cradle to be removed from the mount and replaced without modification by the 16-inch 25-caliber howitzer, which can then be fired up to 65 degrees elevation.

MANY interesting problems in design had to be solved before these mounts could be built. In the case of the 14-inch railway mount, the gun is so large and heavy that difficulty was experienced in designing the mount so that it would be possible for the unit to pass through limiting tunnels in the United States, and to so distribute the weight that it could be transported over existing bridges. While this mount, complete, weighs 660,000 lbs. and is probably heavier than any other piece of equipment being transported over the railroads in the United States, the weight has been so distributed over the 28 wheels that the unit can pass over bridges safely. The mount as designed gives a bridge load equivalent to that of the Cooper's E-50.

In order that the mount may be quickly transported from one place to another, it must not exceed the clearances permitted by various railroads. A standard diagram for all European railroads was adopted at the International Conference at Berne, in 1913. No such diagram has ever been adopted for the railroads of the United States, and it was, therefore, necessary to make a study of this subject before the construction of railway artillery could be undertaken. The minimum clearances of the principal railroads of the United States were obtained by the Ordance Department from the various railroads, and from this data a clearance diagram for the United States was made. Fortunately, the railroads in the United States are built for much heavier loads then those of Europe, and the clearances are also more generous.

A number of these large railway mounts for mounting 14-inch guns and 16-inch howitzers have been built since the war, and platforms have been prepared at selected points along our coast. The guns can be quickly moved to these points, bolted down, and made ready for firing. By using this system, the same guns can be used on the East or West coasts of the United States as required.



LOADING MECHANISM OF A 16-INCH GUN

The shell, weighing about a ton, is so heavy that special handling devices are required. It is brought by a truck, and shoved into the gun by a caterpillar ram.

SINCE the World War a new 16-inch Gun and Barbette Carriage has been developed for use at strategic points along our coast line and for fortifying important places like the Panama Canal and important harbors. This 16-inch gun is approximately 70 feet over all and the gun alone weighs about 200 tons. A charge for the gun consists of 850 lbs. of smokeless powder which gives a maximum interior pressure of 38,000 lbs. per square inch. An armor-piercing projectile weighing 2,340 lbs. is used for attacking the armor of ships and gives a penetration of 14 inches or more of the best armor at all ranges. The maximum range of the gun is about 50,000 yards (or about 28½ miles). The gun with its cradle weighs 550,000 lbs. and is so accurately balanced upon roller bearings that one man by hand-power can easily set the gun at any desired elevation. When the gun is fired the shock of discharge, which amounts to over 1,250,000 lbs., is absorbed in oil recoil cylinders, which dissipate 4,567,000 foot pounds of energy. The gun recoils and returns to battery without any appreciable shock. The gun and carriage is elevated, traversed, and loaded by electric motors which are connected to the carriage through variable speed, hydraulically-operated gearing. Although the projectile weighs over a ton, and the powder charge weighs 850 lbs., the carriage can be fired at a rate of at least one shot per minute, the projectile and powder charge being electrically loaded into the gun. The huge breach block is closed by a pneumatically-operated device.

In conclusion, these huge 16-inch guns emplaced at important points along the coast furnish an almost positive defense against naval attack. It would be economically impossible to adequately defend every foot of our great coast line using permanently emplaced guns. This, however, becomes feasible through the use of the mobile railway artillery.

Assuming that it were possible for an enemy to effect a surprise landing at some unfortified point along the coast of the United States, these long-range railway guns could be quickly mobilized and every foot of advance into the United States could be disposed of by the terrific fire which these long-range guns and howitzers could bring to bear upon the enemy.

An opportunity for watching the behavior of one of these huge mounts on a long trip occurred in July, 1929, when a 14-inch gun was sent from the Aberdeen Proving Ground to the Pacific coast, the entire distance being run at an average speed of 13 miles an hour. That this speed is so low is accounted for by the newness of the carriage. It is expected that when the equipment is broken in, an average speed of 25 miles per hour can be maintained. The only damage to the mount occurred because of defective equipment. All curves were negotiated without affecting the tracks adversely, and all railroad structures were found to have ample clearance both vertically and horizontally. There was no known breakage of railroad equipment. The brakes functioned effectively, and even on long grades there was no sign of excess wear or heating. Its performance indicated the sturdy construction of the mount.

The Engineer and the Stock Market

How Wall Street extends from coast to coast

By E. R. WHEELER '17
Engineering Department
Western Union Telegraph Co.

DURING the past four years, Stock Market activities have received the attention of the entire nation, first because of the steady, long-continued rise of security prices with only minor recessions, and finally because of the spectacular drop during last October and November which wiped out in a few days millions of dollars in paper values. During these years, newspapers expanded their financial sections and devoted pages to discussion of security values. The public apparently became obsessed with the Stock Market craze; even bootblacks and small clerks boasted of their few shares of stock on which they hoped to realize unheard-of profits. From the Atlantic to the Pacific and from Mexico to the barren lands in Northern Canada, the general public was "playing the market."

But in order for them to do this, more information had to be available to them than could be derived from the financial pages of the newspapers. It was necessary for traders in remote sections of the country to receive minute by minute the actual record of trading and sales as they occurred on the Stock Exchange. If this were not possible, the traders in New York City, where the "big" market, the New York Stock Exchange, is located, would have an immense advantage over their remotely located associates.

The general public trades through brokers, who are members of the Stock Exchange or affiliated with firms who are members. Brokers' offices are located in every important city in the United States and in many cities of Canada. In order to create confidence in the minds of the public that their buy and sell orders were executed at the correct market price, a visual printed record of the Exchange transactions early became a desirable feature and soon an absolute necessity. This printed record, in order to be of any value to broker or trader, must be made within a few seconds of the time when the trade occurs on the floor of the Exchange.

HERE then is the field of the quotation ticker telegraph service, a service which has been developed and expanded over a period of years to a remarkable degree, until at present "ticker service" has become synonymous with speed and accuracy. Only a few years ago, business between stock brokers' offices in New York and their branch offices in distant cities was carried on largely by private leased wires operated by high grade Morse telegraphers. On these private wires as many stock quotations as time would permit were sent to the branch offices for their clients' information and the wire was utilized in the return direction for buy and sell orders. Only a small portion of the market quotations were made available to the branch offices in this way as the Morse operated wire could not carry the full volume of business. Now this has been changed, and in any part of the country quotation ticker service may be obtained at the brokers' branch offices, giving exactly the same market information which is furnished brokers in New York City and with only a few seconds difference in time.

FIG. 1. THE CALAHAN TICKER
This is the first real ticker which printed on a strip of paper tape. It was patented in 1868.

Quotation ticker service has been operated in New York City since the early part of 1866, when an indicator devised by Dr. S. S. Laws was operated in brokers' offices in New York City from a central transmitting office. This indicator displayed prices of gold, then the principal commodity traded in, on drums or discs, but did not make a printed record. Edward A. Calahan in 1868 designed and patented the first real ticker which printed on a strip of paper tape. This ticker (see Figure 1), required three wires from the transmitting office for its operation and was comparatively slow, but it contained fundamentals of design which have been more or less common in every ticker design since, until the last "High Speed" ticker which is about to be put into use.

One of Thomas A. Edison's earliest applications of inventive genius was his design of the Universal Ticker. This instrument was made in 1870 and is still in use in considerable numbers today. It has remained in the field when so many of the later designs were abandoned because of its simplicity of design and operation, rugged construction and ability to work at moderate speeds for long periods without requiring adjustment or repairs. This ticker operates on two line wires, requires 300 milliamperes current on each wire and will print about 120 characters a minute. It operates from a direct keyboard which looks somewhat like that of a piano. There is one key for each letter character, and shift and unshift keys to change from letters to figures. A motor on the keyboard rotates two commutators and a stop pin barrel. The ticker typewheel rotates or is driven by current impulses from the commutator and is therefore in phase with the keyboard operation.

From 1870 to 1890 the names of George M. Phelps, Charles T. Chester, Stephen D. Field, George B. Scott and John Burry are each associated with designs of various tickers. They had many points in common and the most radical change of design was utilization of a weight in the ticker to supply the driving power. The customer was obliged to wind this up two or three times a day, and it would then descend slowly like a clock weight, furnishing a motive power for the rotating parts of the instrument. An improvement of the Field ticker is in use by the New York Quotation Company for their Stock and Bond systems and Burry's tickers are still in use in some exchange services.

ANOTHER type of ticker came into being in 1903 and has remained since, giving a very satisfactory service. This was the Western Union Self-Winding Ticker. A large number of these instruments are in regular daily service, handling the quotation ticker service of perhaps twenty different exchanges. This machine requires two wires for local operation with 300 to 350 milliamperes signalling current on each wire. It can also be extended and controlled over one wire for operation over great distances if repeating relays are used at the receiving end. This one wire system is employed for distribution to distant cities. At the present time the New York Stock service is handled on these Self-

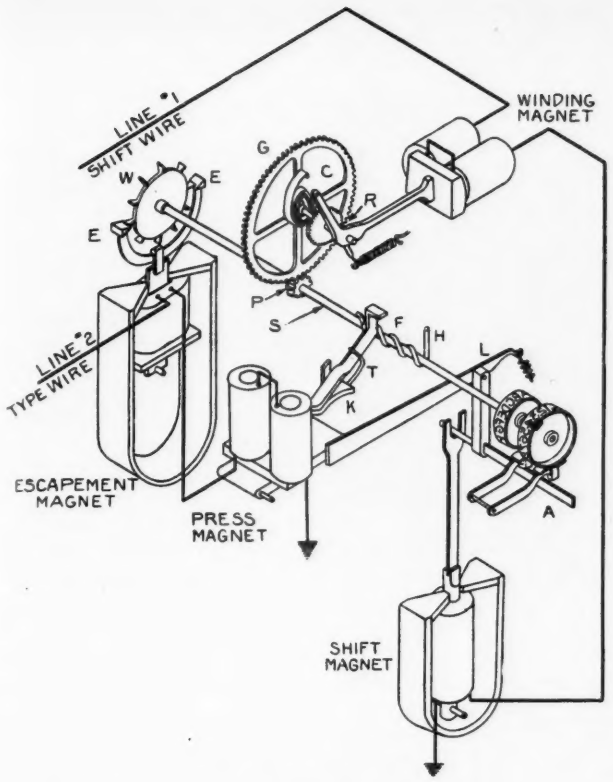


FIG. 2. THE SELF-WINDING TICKER

Two line wires are required. Over one is sent the impulses which cause the rotation of the type wheels and determine whether a letter or figure is to be typed. Over the other comes the control of the rotation of the type wheels and the actuating of the printing mechanism.

Winding Tickers. About 22,000 miles of single wire trunk line circuit is included in this one service, exclusive of the local city two-wire circuits.

The Self-Winding Ticker is probably the best example of a fast step-by-step operated printing instrument. For this reason a brief explanation of the essentials of its operation is given here. A schematic diagram (Figure 2) will assist in following the explanation. As before stated two-line wires are required for its operation. The type wire passes through two magnets, the escapement and the press. Alternating current is transmitted over this line wire and as it passes through the winding of the escapement magnet the armature will follow the reversals and move back and forth between the poles of the permanent horseshoe magnet. The alternating current impulses do not affect the press magnet. A clock spring *C* mounted on the large gear *G* is kept wound up by impulses sent over the shift wire through the winding magnet. The tension of this spring is applied through pinion *P* of the typewheel shaft and is always trying to rotate the typewheel. The escapement acts as a control on the rotation of the typewheel shaft. On the typewheel shaft are rigidly fastened two typewheels, one carrying figures characters and one carrying letters characters. Paper tape is passed between the typewheels and striking hammers *A*. Each movement of the escapement allows the typewheels to advance the space of one character. A sufficient number of escapement impulses are sent over the type wire, therefore, to rotate the typewheel to the character it is desired to print and then a long impulse is sent which energizes the press magnet and causes the tape to be raised against the typewheel. If the letter *A* has been printed and the letter *B* is to be printed next, the escapement allows the shaft to revolve one step, thus bringing *B* over the printing point. If letter *G* is to be printed next, the shaft revolves through the *C*, *D*, *E* and *F* steps and stops with the letter *G* in the printing position. There are two printing hammers, one for letters and one for figures. The shift magnet, connected in the shift wire determines which hammer is to be raised against the type wheel. The shift magnet is a polar magnet and, therefore, an impulse of one polarity throws the shift lever under the figures hammer whereas the opposite polarity will throw the shift lever under the letter hammer. The winding magnet is actuated by make and break impulses of either polarity.

It is, therefore, seen that two-wire operation of this step-by-step ticker requires on one line, pulsating current to operate the winding magnet and a reversal of polarity to control the shift magnet, and on the second line requires alternating current to control the movement of the typewheel and a long impulse to actuate the printing or press mechanism. The mechanism of this type of ticker is, therefore, controlled entirely by impulses sent over the signalling wires and power for all of the operations of the ticker is transmitted over these same signal wires.

THE Self-Winding Ticker of the step-by-step type was adequate to handle the New York Stock Market until the daily volume of trading was between three and four million shares. Delays then became frequent, especially so when the activity on the Exchange was concentrated in an hour or less instead of being uniformly distributed over the entire five-hour trading period. For after all, the real test of a ticker system is not its ability to handle regular, steady reports but its latent capacity to absorb and distribute the frenzied sales and activity of a market break. The ticker system in use in 1927 when the continued increase in market activity became apparent was capable of delivering sixty quotations per minute. Criticism on the part of the brokers began to be manifest when at times the ticker was twenty minutes or more behind the market. Even before this, however, the telegraph engineers were busy on the problem of designing and putting into production a faster machine. The step-by-step principle was abandoned entirely as experience had shown that the maximum possible safe output of

(*Continued on page 112*)

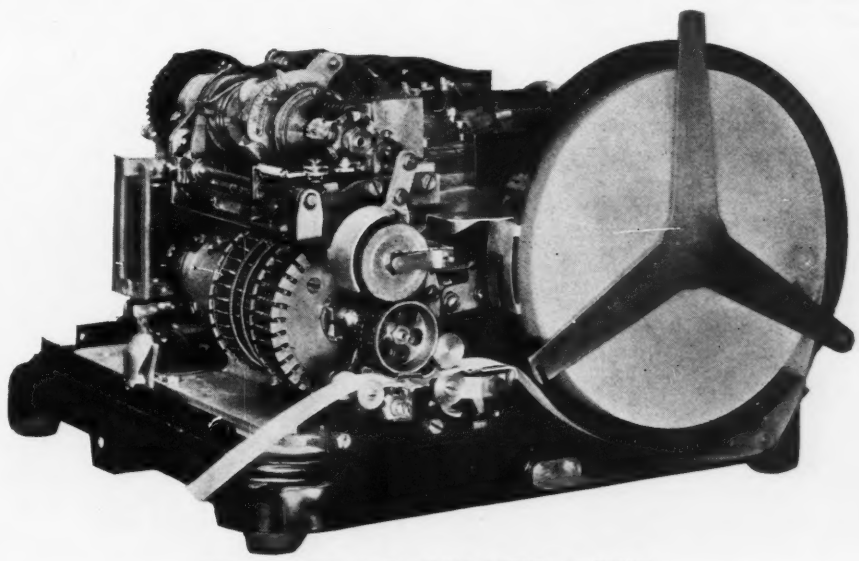


FIG. 3. THE NEW HIGH SPEED TICKER

The small type wheel in the foreground is rotated by a friction clutch as is the upper shaft which carries the selection mechanism.

Yacht Racing

The sport of kings and the problem of the naval architect

By GEORGE OWEN '94
Professor of Naval Architecture
Massachusetts Institute of Technology

YACHTING, the Sport of Kings, is in itself a sport, but there is so much money invested in it that it also has acquired an engineering and business interest. The designing and constructing of boats has been constantly developed through the ages and is a long story in itself. The peak of commercial sailing craft was reached in those much praised days of the Clipper Ship era. Since then sail has gradually fallen out of use in commerce, but has had a corresponding rise in sport. During the last fifty years there have been many refinements that may be directly traceable to the many races for the America's Cup.

There is one way of really testing the actual worth of any new design or new method of construction in yacht building and that is by racing under all conditions. The thing desired of the America's Cup defenders above all else is speed. This summer there will be very thorough elimination trial races under many different conditions. The winner of these trials will then race the challenger, *Shamrock V*, for the historic mug. This race and its trials are causing more international interest than any yachting event since the beginning of yachting history.

For the first time, an international race will be sailed under the American Displacement Rule of measurement which is represented by the formula:

$$\text{Rating} = \frac{\text{Load water line length} \times \sqrt{\text{S.A.}} \times 0.18}{\sqrt[3]{D}}$$

The New York Yacht Club is now using this formula in which *S. A.* represents sail area and *D*, displacement. The rating of these boats has been selected arbitrarily as 76. The reason for a rating rule is quite apparent, as this is the only way that one can be sure of fair competition. This rating rule is not only applicable to this style boat, but to all racing sailboats. The approximate spread of sail of all of these boats will be 7,600 square feet, depending upon their respective load water lines. These rules also restrict the maximum number of men allowed on board during a race. Thirty-one is the number allowed on a 76 rating yacht. The men will not have cabin accommodations on board, as it has been decided by mutual agreement that their crews be berthed and messed aboard accompanying tenders, as is the usual custom among larger racing craft.

The trophy that is now known as the America's Cup was won by that vessel from the Royal Yacht Squadron on August 22, 1851. During the year 1851, England held a great industrial exhibition at London and also a series of yacht races, as befitted a great seafaring country. With the purpose in view of entering several of these races a champion schooner, the "America," named for the country from which she hailed was sent across the Atlantic. Many attempts have been made by other countries to recover this cup, but none have succeeded. Millions have been spent by challengers and defenders, while a simple silver cup, valued originally at $500, has come to represent the supremacy of the seas.

"RELIANCE," A FINE PIECE OF MARINE ENGINEERING
With a loaded water line of only 90 feet she carried 16,000 square feet of sail to successfully defend the cup in 1903.

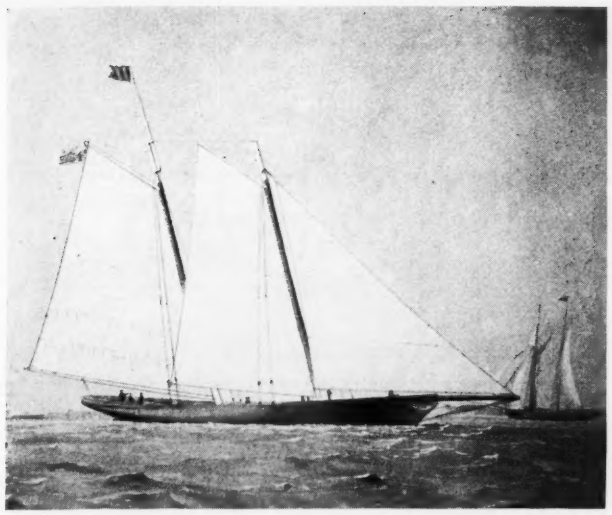
MOST of the recent contenders for the America's Cup have been of extreme design and light construction. Under the present racing rules all of these boats are required to be built with substantial scantlings, and in accordance with Lloyd's requirements. These are the requirements that all commercial boats have to meet before they can be insured. An idea will be gained of the comprehensiveness of these requirements when it is known that they are published in a good sized volume. With proper care, these boats should have a relatively long life as their hulls will be very securely put together. This feature will make the boats more desirable as cruising yachts after the trials and race are over. When cabin fittings are installed, these defenders will make splendid, livable, and durable pleasure craft.

The cost of building and operating one of these racing yachts during this one season is estimated to be not less than $500,000, and possibly considerably more. An interesting comparison can be made which shows that all prices have had a considerable increase in the last half century. The America's Cup Defender *Puritan*, in the year 1885 did not cost more than $30,000 to build and operate and this same yacht was of about the same general size of hull and sail spread as the competitors of this year. The difference between the two costs seems extreme at first glance but almost all of this increase is directly in proportion to the general rise of prices that has been prevalent during the period.

THE challenger, *Shamrock V*, is now being built at Gasport, England, from the designs of Nicholson. Sir Thomas Lipton, the almost perennial challenger, is now embarked on his fifth crusade for this historic cup. His yacht is of composite construction, that is to say, having steel frames and planked with wood. Her water line when loaded is reported to be about 79 feet, which is shorter than any of the defenders.

Each of the candidates for the cup defense is owned by a syndicate or group of prominent yachtsmen. The boat will be of a somewhat different type than that of the accompanying illustrations in that they will have longer hulls and no bowsprits. These older defenders were not a very desirable boat as a whole, and the new ones will appear very short rigged when compared with them.

FROM the drafting board of W. Starling Burgess comes the *Enterprise* which is owned by a syndicate of New York yachtsmen headed by Harold S. Vanderbilt and Winthrop W. Aldridge, with Mr. Vanderbilt as manager. At the date of this writing she is nearly completed in the shops of the Herreshoff Manufacturing Company at Bristol, Rhode Island. Most of her ballast is cast in one piece of outside lead. She is reported to be of eighty



"AMERICA" THE FIRST CHALLENGER
She crossed the Atlantic in 1851 to bring back the international trophy that bears her name.

feet load water line and to be plated with bronze over frames of steel.

GEORGE NICHOLS is the manager and with Junius Spencer Morgan, Jr., heads the syndicate of New York yachtsmen which owns the *Weetamoe*. This was the second group to be formed for building a cup defender. She is also under construction in the Herreshoff shops at Bristol, but was designed by Clinton H. Crane. *Weetamoe* is said to be of eighty-three feet load water line length. Like the *Enterprise* she is being plated with bronze over steel frames and will carry most of her ballast in the form of an outside lead casting.

A SYNDICATE of Boston yachtsmen headed by Frank C. Paine and Chandler H. Hovey with John S. Lawrence as manager are entering the *Yankee* in the coming trials. She is now under construction at the yard of George Lawley and Son in Neponset, Massachusetts, from the designs of F.C.Paine. Her load water line length is reported to be eighty-four feet. It will be noticed that the boats are longer as their dates of conception become more recent. She is being plated with bronze over steel frames, but unlike *Enterprise* and *Weetamoe* is to carry all of her load ballast inside stowed low in the pockets between the steel floors.

THE *Whirlwind* is owned by a syndicate headed by Landon K. Thorne and Paul L. Hammond, both of New York. L. Francis Herreshoff designed her and she is now also under construction at Neponset in the shops of George Lawley and Son. She is reported to have a load water line length of eighty-six feet which makes her the largest of the four defenders. Like the *Enterprise* and *Weetamoe* she will have steel frames and outside lead ballast, but unlike the other three defence candidates will be planked with wood. Also unlike any of her class competitors, *Whirlwind* will show the sharp stern and the double ended type of which L. Francis Herreshoff is so fond. The planking is almost half on her at this date. The inner skin is one inch and the outer an inch and seven-eighths.

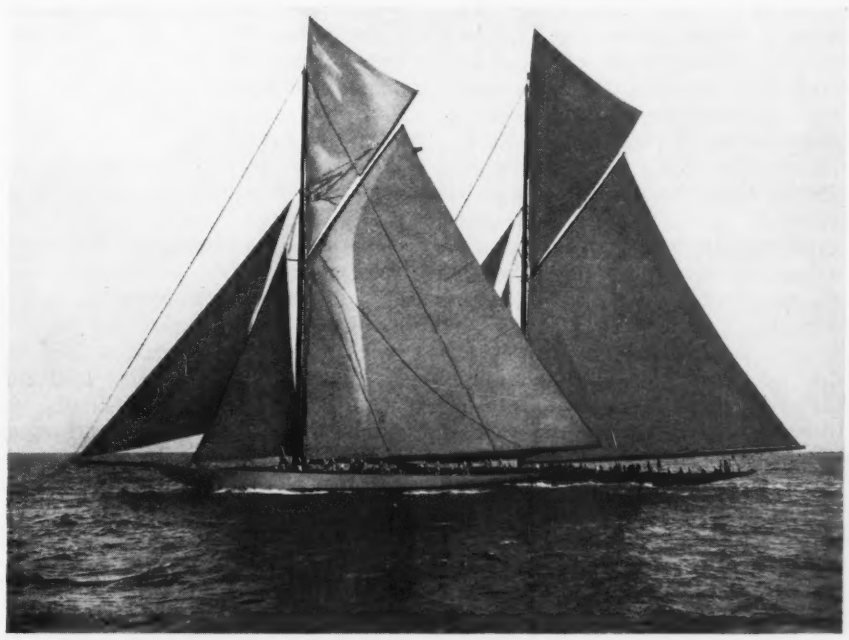
These yachts will probably be launched by the end of April and until that time very little of the detailed design will be made public.

Perhaps the best way to visualize the size of the defenders will be by a comparison with the most recent America's cup yachts the *Vanitie* and *Resolute*. At the present time these yachts have a flotation length of about seventy-six feet but since they carry about 8,000 square feet of sail they have a rating or racing length of 78 feet, as compared with the 76-foot rating of these new yachts. An idea of the sturdiness of construction of this type boat will be conveyed when attention is called to the fact that the *Vanitie* and *Resolute* built in 1914, although of much lighter construction than the present defenders, have been raced for many seasons in a very hard manner and are still perfectly sound and in splendid condition.

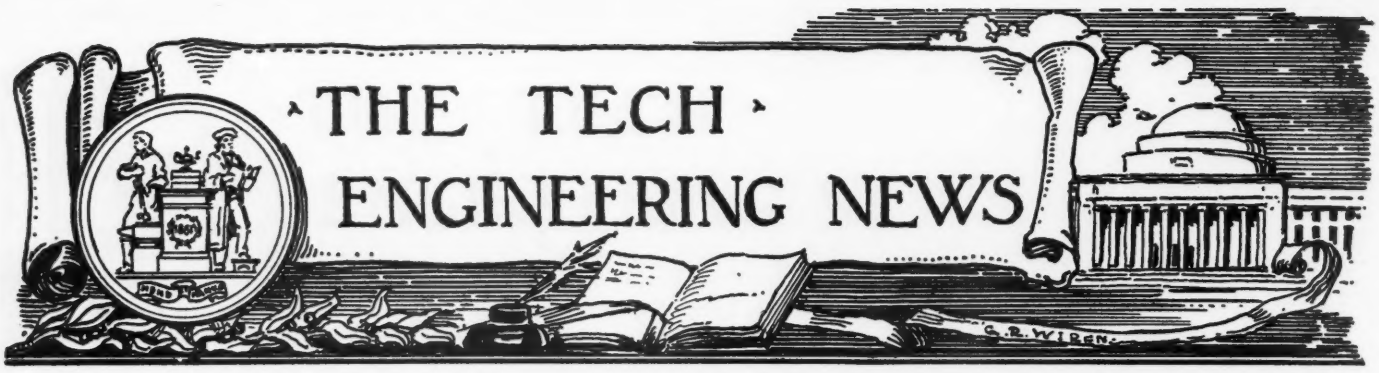
A few miscellaneous bits of information relevant to the defenders as a group might be brought in here before concluding the article. The rig will be of the so-called Marconi or jib-headed type. This is quite natural as more and more rigs are being changed from the old-fashioned gaff to the newer Marconi. The maximum speed that they will be able to obtain will be about 13 knots. While to the power boat man this may seem absurdly slow, it is very fast travelling for a sail boat of this length. The fabric in the sails of these yachts will be woven from the very highest quality of Egyptian grown cotton, corded, combed, spun, and woven in mills specializing in the making of high-grade duck. The rigging is mostly of wire rope which is specially galvanized to protect it from corrosion. Plow steel, having a breaking point of about 400,000 pounds per square inch, is used in the construction of this wire rope. The pulley blocks are designed for their particular uses and boats and are half as heavy as a commercial block capable of withstanding the same load. The spars are all hollow and are made by gluing together innumerable pieces of small bits of wood with a waterproof glue especially made for this purpose. The result is that the spars are far lighter and stronger than ordinary wooden spars of the same dimensions.

It is only by attention to all of these minor points that one yacht will be able to excel.

Because of the high quality of intelligence and experience of the owners, designers, and builders of these yachts, many practical lessons in yacht construction and handling should be learned and the general sport of yachting greatly advanced.



"COLUMBIA" AND "SHAMROCK II"
Maneuvering before the start of the America's Cup race of 1901.



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Editorials

SCIENTIFIC THINKING

PROBABLY one of the most important things we learn while here at Technology is to get all of the facts about a problem before coming to a conclusion. This sifting of data and viewing of a situation from all angles is not a common characteristic of human nature; in fact, it is quite the contrary. Too often we jump to conclusions without knowing, and without thinking what they are based upon. Scientific training attempts to teach men how to investigate and how to think, to try and get them to seek for the truthful answer rather than be influenced in any direction by forces having no bearing on the question at hand, or by their own personal desires as to what they wish the answer to be. Yet the greater proportion of the world's people prefer superficial treatment of any matter as the easiest and most comfortable; they prefer to look only on one side of a picture; to believe only those things which are pleasant and easy to believe and which do not require too large an expenditure of mental effort. They are afraid to turn it over for fear they may find some unpleasant evidence which will destroy the pleasant illusions they have in their mind. That is the type of mentality which breeds extreme optimists. There are perhaps some arguments for them, for their beliefs make them personally happier, as they, seeing only the best side of things, believe that everything is tending towards the best. Yet that very characteristic often brings them into disrepute. It denotes, when carried to extremes, mental cowardice, the fear to see things as they are, or else it denotes mental atrophy. It is a form of self-deception, and the mentally awake prefer not to be deluded but to know the actual facts. Besides that, the doctrine that things are now perfect, or are of themselves tending towards perfection, reduces that driving force in man which is greatest when he is working hardest to overcome great difficulties. Such beliefs prevent him from seeing and improving existing evil conditions.

A real scientist wants truth, not delusions. If he holds a theory which is false, he would rather be proved wrong than go on believing it. The scientific method of thinking means true advancement for the world. The world needs men who dare to think for themselves, to question, to doubt, to whom nothing but the truth is sacred, who are unfettered by past superstitions, and whose only desire is to find out what the true facts are.

UNNECESSARIES IN EDUCATION

IN an article published in a magazine of nation-wide circulation, Edward W. Berry, Dean of Johns Hopkins, comments upon the curriculum of institutions of higher learning. He makes a sweeping criticism, stating that too much time is wasted on unnecessary material. Dean Berry says, "When a boy knows what he wants, he should be encouraged to go after it in the shortest and most direct route."

It is probably true that people who have definitely in mind what they plan to do upon the completion of their college course are somewhat hampered by the necessity of taking a standard course, in which material unnecessary to their end is included. For these people, some arrangement whereby the omission of such material could be ef-

fected would benefit them. The rub is this, however, that few people do have definitely in mind what they plan to do upon graduation.

It is with these in mind that a basic course of instruction must be laid. It must be so built that the person taking it may at will branch out into any desired specialized study. He may find that some of the material he first studied is useless to him, but how was he to know that? Furthermore, some things which he may decide at first to be useless will benefit him later. Take, for example, the experience of the writer with freshman mechanics. The extent to which this subject was to enter his future work was almost unknown to him, and he was inclined to slight it. Now he regrets it! For mechanics pops up in the most unsuspected places. It is the disguised basis of many other more interesting studies; and even where it is not an absolute essential, it reaches out of the crannies of scientific knowledge and snatches at the unwary. There is still something to be said for the standard curriculum. Let the undergraduate not slight those things which older heads deem necessary to his success.

Bachrach

PROFESSOR SAMUEL C. PRESCOTT

Professor Prescott, Head of the Department of Biology and Public Health, was himself a student of the Institute in the class of '94, as were many of our professors. He was born at South Hampton, New Hampshire, on April 5, 1872. In the same state, at Sanborn Seminary, he prepared for M. I. T.

Soon after graduating he returned to the Institute as an assistant to Professor Sedgwick, and in 1896 was made instructor. Since that time he has been directly connected with the Institute and very much interested in everything that concerns it. His climb in the department was gradual but steady, and in 1922 he was made its Head.

In conjunction with his work at the Institute he has handled many research problems of great importance to industry and the public. To fill the need for a commercial laboratory for this field he established, in 1905, the Boston Bio-Chemical Laboratory with which he continued to be associated until 1922. Several trips to the tropics from 1912 to 1917 resulted in the study of some important problems of the United Fruit Company, and a report on the examination of tropical sails.

He served as a Major in the Sanitary Corps during the war. While in charge of food storage and research problems he did some very valuable work on the dehydration of foods. The solution of this problem made it possible to transport food at a great saving in space.

On returning to his teaching work after the war, he did much research, in which the search for the perfect cup of coffee was carried on for a space of three years and resulted in some publicity. This particular research has caused much attention both because of its importance and its appeal to the people as a whole.

Fishing and outdoor sports of a varied nature are the main interests of the Professor outside of his field of endeavor.

Professor Prescott is very active in much of the administrative work of the Institute. At present, he is Chairman of the Faculty, and also the Chairman of the Committee for revising the courses of the first two years. The Alumni Association, of which he is a past president and a present member of the Executive Committee, commands a good deal of his time, interest and energy.

In addition, many problems of a technical and general interest, such as domestic refrigeration, dehydration, coffee, industrial hygiene, and the formation of commercial solvents by fermentation have had the consideration of Professor Prescott and his associates.

EXPRESS YOUR OPINIONS

THE TECH ENGINEERING NEWS has completed ten years of successful service at Technology. It has earned an enviable reputation for itself both among the publications here and among college engineering publications everywhere. Yet we are not pleased with its success. It does not receive the widespread student attention that an undergraduate paper should command.

It is our wish to furnish Tech students with a journal that will be read and appreciated by them. A criticism has been directed at us that our material is too heavy; that, although it is authoritative, it cannot be read with the despatch that the hurried life of the Technology student demands. If our readers feel that such is the case, we should like to hear a definite expression of opinion from them — not only on our present form, but on what they believe to constitute an interesting publication.

SECTIONING FOR SPEED

A CRITICISM frequently directed against American educational institutions is that they are designed to meet the needs of the average student. The work is just difficult enough to let the average student by; the methods of instruction are adjusted to his intelligence. In the class method, little time is available for individual instruction. The result is that the student above the average is as likely to be hurt by an inefficient utilization of his mental powers as the student below the average is to be hurt by the requirement of a mentality he does not possess.

With this situation in mind, the Department of Electrical Engineering has divided its classes into sections, the students in each section having about the same mental ability. This arrangement makes it possible for each student to receive instruction adequate to his needs. In our opinion, this is a very wise arrangement, and one that should gain wide recognition. It is especially important that this type of instruction be adopted in preparatory schools, where the habits of study which will be pursued throughout the rest of a person's education are formed. A person who finds in preparatory school that the work is simple, allows it to lag somewhat — not from any intention of his own, but from a want of the course of study to tax his brain power. Having reached an institution of higher learning, he finds his lax methods of study hard to overcome, and since the comprehension of his courses is more difficult, his scholastic standing slips. This has happened in the past, and will continue to do so unless proper steps to prevent it are taken.

THE ENGINEER AND THE STOCK MARKET

READING Mr. Wheeler's article on the ticker service brings once again to mind the part the engineer is playing in tying the world together. All over the United States, the transactions of the New York Stock Exchange can be known almost instantly. Such an arrangement was undreamed of a hundred years ago; and the rapid expansion and coördination of the business of this country can be laid in part to this device.

For thousands of years, men have tried to overcome the bounds which have tied them to one region. Slowly at first, and then with an overwhelming rapidity as the age of industry was ushered in, has the development of means of communication proceeded. Daring flights of imagination and dogged perseverance in the pursuit of perfection have brought the world to an almost unbelievable unity. It is hard to realize how an event in Russia can cause a flurry in the Chicago Wheat Pit.

We welcome these growing bonds between nations. Not only is business benefited thereby, but if the world is to be ever at peace, it will be because these bonds have brought the people of the earth so close together that misunderstanding and distrust have been forgotten.

THE COVER

A FORMER cup defender, the *Reliance*, built by Herreshoff in 1903, is the subject of the cover photograph for this issue. She has by far the largest sail area of any boat of her size. One will get a better idea of her length, which is 90 feet at the water line, if he notices the number and size of the men clinging to the windward sail. From the water to the top of her mast is 176 feet, approximately seven-fourths the height of the flagpoles at either side of the great court.

The Engineering Field

Abstracts from the leading professional and trade journals

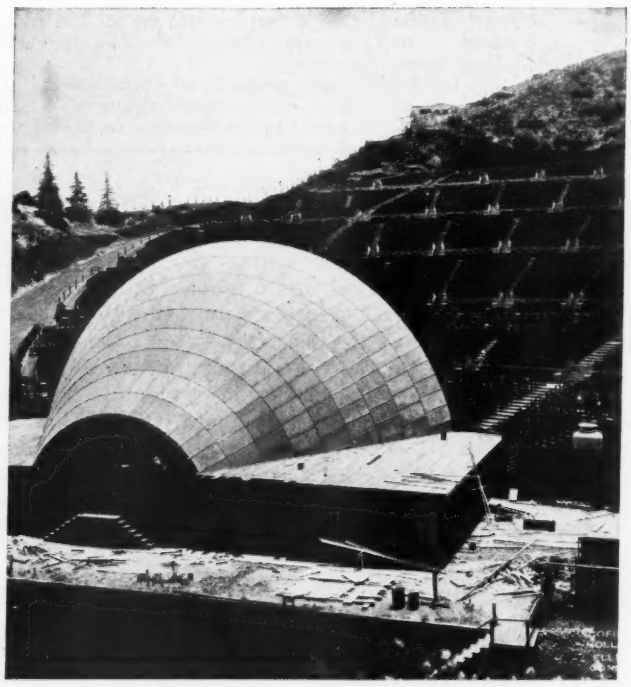
A Bowl Sound Reflector has been constructed for an open-air amphitheatre in Hollywood, California. The structure is in the shape of half a truncated cone, and is designed to make speeches and concerts clearly audible at all of the 25,000 seats in the theatre.

The shell structure is built entirely independent of the stage on which it rests, and is mounted on wheels so that it may be easily moved. The superstructure of steel is covered with asbestos sheets both inside and out, while the floor is of wood, mounted on steel I-beams. The function of the shell is to project the sound with equal intensity over the entire area, covering a maximum linear distance of 560 feet.

Previous trials with orchestral shells had shown disturbing effects due to the overemphasis of those instruments located at the foci of the parabolic surfaces. This difficulty was overcome in the new design by the use of several concentric circular bands on the ceiling of the shell. As it is now constructed, it is free from all such acoustical defects. Slight preference in the volume of reflected sound is given those in the rear seats, while the direct waves audible in the front make up the difference. As a result, volume of sound is equal over the entire area.

Rough tests of the efficiency of the structure revealed that a No. 10 bird shot, weighing .00115 ounce when dropped one-quarter inch onto the surface of a kettledrum produced enough sound to be audible over three-quarters of the amphitheatre. Numbers and sentences whispered on the stage were clearly audible in all seats.

A particular feature of the shell is a duck canvas curtain which protects the interior from the weather, and an awning which is used during rehearsals. By means of steel ropes and power winches, the entire shell may be removed from the stage and out of sight behind a nearby hill so that pageants may be held on the outdoor stage.



Courtesy *Engineering News-Record*

REAR VIEW OF HOLLYWOOD BOWL

The orchestral shell includes the latest design features.

Hoist and Shovel Attachments for tractors are proving quite useful. The shovel attachment is composed of a bucket 46 inches wide made of one-quarter inch steel, controlled by a mechanical clutch-operated hoist. The assembly may be mounted on a tractor equipped with either wheels or crawler threads. The power is transferred from the tractor motor to the shovel by means of a roller chain drive and a multiple dry disk clutch.

The bucket has a lifting height of 40 inches and a dumping clearance of 25 inches. As it has an over-all height of only 69 inches, it can easily work in small places where a steam shovel could not operate effectively.

A tractor of the same type may also be equipped with a hoist. The hoist, composed of a drum 8 inches in diameter and an auxiliary drum 9 inches in diameter, is driven by the tractor motor through a roller chain. The hoist is controlled by hand levers and is easily changed from single to double drum type or vice versa.

A Portable Fire Extinguisher employing liquid carbon dioxide instead of the former liquid chemicals has at last made its appearance. Although the liquefaction of carbon dioxide has been known for quite some time, it has been the custom in the past to employ chemicals which generated the gas on the spot. The new extinguisher resembles the present type of portable extinguisher with the exception of a conical nozzle which allows the gas to vaporize quickly on release. The extinguisher is of special value in the event of fires on switchboards, transformer vaults and other wiring where the gas does not cause a short circuit as would liquid extinguishers. At any fire, the use of this new method results in a great saving of property which is usually destroyed by the corrosive action of chemical extinguishers.

The Fastest Cable in the world has just been opened to public use. Running between Newfoundland and the Azores, it embodies all the latest principles of design and electrical engineering.

The two ends, extending 160 miles from the shore, are built of copper and gutta-percha sections weighing 500 pounds and 300 pounds respectively per nautical mile. There follows a 70-mile section of 325 pounds of copper, 50 pounds of mumetal, and 270 pounds of gutta-percha per nautical mile. The deep-sea section contains 280 pounds of copper, 60 pounds of mumetal, and 225 pounds of gutta-percha per nautical mile. The copper forms the core and is surrounded by five spirally wound strips on which the mumetal is wound. Mumetal is a nickel-cobalt-iron alloy which permits the passage of eight simultaneous messages, four in each direction.

A Light Fuel Tank for aeroplanes is now undergoing tests. The tank is constructed with terneplate steel sheeting .018 inch in thickness and crimped with a .25 inch pitch. Interior baffles are of .032 inch hard dural riveted together and to the shell. All seams are soldered and rivet heads are also soldered over to insure freedom from leakage. Although the tank has a capacity of 50 gallons, it weighs but 32 pounds when empty, or .664 pound of tank weight for each gallon capacity. A system of internal bracing is used which adds to the strength of the tank. This tank has withstood pressure of five pounds per square inch without leakage, failure, or permanent disruption.

A Cabin Top for Airplane Cockpits is being developed for use on the New York-Chicago mail planes. The device is in reality a windshield with a cabin section built onto it. Visibility

is afforded through glass windows on three sides of the structure. The main features provided by it are protection for the pilot and additional warmth.

The glass on the sides can be slid back at will, and in case of emergency, the whole cabin top may be released from its supports by a safety lock, thus enabling the pilot to escape in a parachute. If tests prove successful, it is expected that the new device will become standard equipment for mail planes.

Welded Steel Flooring may make possible 200-story buildings in the near future. This new type of construction reduces the weight of the structure a great deal. It is estimated that a 25% increase in the height of buildings can be obtained without increasing the load on the foundations.

The welding is done by a small self-propelled machine consisting mainly of a wire feeding device, a reel of welding wire, the travel motors, and the control devices. The whole apparatus is operated by electricity which is received from a remote point by a trailing cable. When in use the machine is placed at the beginning of a seam and started running. It follows the seam, being guided by hand if necessary, welding the steel plates at a speed of nine and one-half inches a minute.

The floor produced is exceedingly strong, resisting torsional distortion due to wind or earthquakes. The notable feature about the machine itself is its simplicity and ease of operation.

Lack of Parking Space in Seattle, Washington, resulted in the use of garage roofs for this purpose. Storage of cars on top of buildings has been encouraged by the authorities of that city in order to reduce traffic congestion. Several garages have already erected roofs suitable for this purpose, and it is expected that the movement will be followed shortly in other cities.

One such roof parking-space consists of a flat reinforced concrete flooring covering the entire top of a small city block. The floor is surrounded by a concrete rail ten feet high against which cars are stored. An inclined roadway leading from the floor below permits access to the roof, and a shack for attendants facilitates handling of the cars and servicing. Exposure to the weather, the greatest disadvantage of the system, is not serious, inasmuch as storage usually covers short periods of time during rush hours.

Automobile Fuel from Cornstalks is one of the latest uses for farm waste. The lowly cornstalk, already serving many uses, may now be decomposed, along with sewage, to form a gas that may be utilized to operate autos, heat homes, and drive electrical generators. Chemists, as well as recovering this methane gas, are also retrieving carbon dioxide gas, from which "dry ice" is made.

Chemists now have a simple apparatus which the farmer may use to turn his cornstalks into cooking and heating gas. The stalks are shredded, boiled, then soaked in water and lime. They are placed in a covered tank to collect the gases, which are the product of fermentation. It is estimated that fifty square miles of corn land would furnish enough gas for a city of 80,000 people, if fermented by this method.

Courtesy *Engineering News-Record*

PARKING ON ROOF GARAGE

Automobiles are being stored on roofs in Seattle, Washington.

Poisonous Exhaust Gases and foul air are being detected by means of a "robot" in New York's Holland Tunnel. Mounted in a dark air vent at a point where the haze is normally thickest is a small electric light with a photo-electric tube beside it. One hundred and fifty feet away is a target consisting of two mirrors at right angles to each other. A light beam from the electric lamp is reflected from one mirror to the other and back to the photo-electric tube. As the exhaust air passes through the vent, the intensity of the reflected beam is varied, producing changes in the amount of current passing through the cell. These changes are amplified and passed on to a recording device in the tunnel supervisor's office. This official is thus informed at any time of the amount of smoke, and can regulate the fans so as to keep the air condition always up to a high standard of purity.

The device also has great possibilities as a fire alarm for warehouses. One mounted near the ceiling would be certain to give the alarm at the first appearance of smoke.

Four Separate Beams of Light emanate from a single source in a new airport beacon. The Scott Beacon, as it is called, is capable of projecting one vertical and three equally spaced horizontal beams from one main light source.

The beacon is built in the form of a closed aluminum cylinder 58 inches high, enclosing a light source of from one to five kilowatts, depending upon conditions. The beams are projected by four separate mirrors through lenses of white, green, red, and transparent glass. The light revolves at six r.p.m. and produces alternate flashes of the three colors. The aluminum housing readily absorbs the heat from the large light and thus safeguards it.

Each horizontal beam is projected as high as 15° above the horizon and thus makes an effective signal for all practical heights. The beacon operates on the principle of diffused light rather than on that of the concentrated ray. Visibility tests have shown the former to be more effective over greater distances, especially when poor weather conditions prevail around our airports.

An Automatic Idling Device for controlling the speed of a gasoline engine-driven welding set has been perfected

The device consists principally of an electro-magnet and a small metal bellows. When the arc is struck the magnet opens a relief valve in the bellows which expand and allow a spring to open the engine throttle. When the welding is finished and the arc broken, the motion in the intake manifold of the engine, which is connected to the bellows, deflates them, closing the throttle and slowing the engine down to idling speed.

This device promises to be a valuable attachment to an engine-driven set, especially where there are long intervals between welding operations, as it eliminates the necessity of stopping and starting the engine continually, or of running it steadily while no current is being used.

Departmental Notes

DEPARTMENT OF ELECTRICAL ENGINEERING

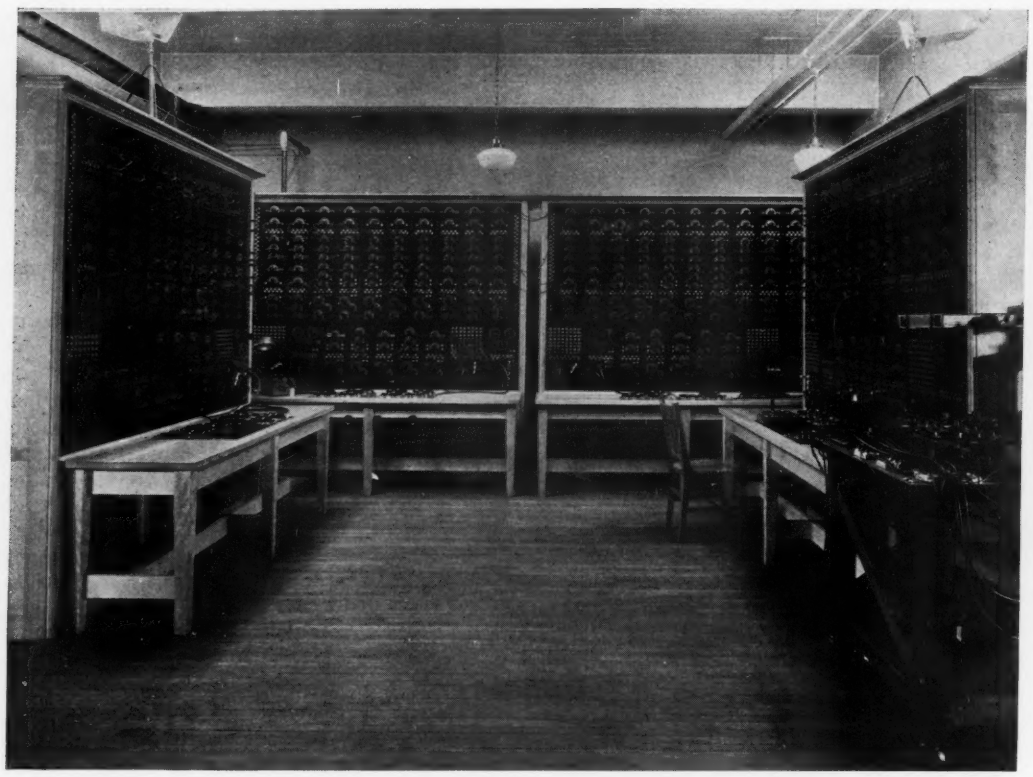
THE instruction of the Department continues to rest fundamentally upon a mathematical-physics basis; emphasis is placed upon the understanding of principles and not upon details of design or practice.

The plan of sectioning in accordance with mental speed continues to be used with success. At the beginning of the study of Principles of Electrical Engineering, the students are divided among sections of about twenty men or less in accordance with their previous records primarily in Mathematics and Physics. For want of better terms the sections are designated as fast, intermediate, or slow, though the scope of work in all sections is the same. The motive behind this grouping is to take cognizance of the fact that different students learn with varying degrees of ease and rapidity. In the slow section drill and repetition are the order whereas instruction in the fast sections is characterized by less textbook work, more mathematics, and the use of more collateral sources of information. The object is to strengthen the grasp and deepen the understanding rather than to increase the range of the subject matter.

AN extension of this scheme is the Honors Group plan, though it is more comprehensive, for it relates to all subjects of instruction taken by electrical engineering students in the junior and senior years whether given by the Department of Electrical Engineering or by other departments. The object is to encourage initiative, originality, and sense of responsibility by creating an independent atmosphere of work with more than usual freedom from routine and rigid requirements. Students are selected for the Honors Groups, from those who apply for the privileges, at the end of the sophomore year on the basis of the excellence of their previous scholastic records and personal qualifications. Honors Groups students may attend the usual class exercises or not as they wish, are expected to avoid unnecessary repetition by solving only those practice problems which illustrate principles new to them and are given considerable latitude in the pursuit of laboratory investigations. They are required to attend all previously announced written quizzes in all their subjects and are expected to pass creditably the usual term examinations. For the purpose of assisting in making progress orderly and in overcoming unusual difficulties, general counselors are available from the staff of the Electrical Engineering Department and special conferees from the staffs of other departments in which honors students take subjects. Honors students are expected to work primarily under the direct guidance of these men and by doing a large amount of reading collateral to their field of study, rather than by attending a large number of set exercises.

The work for all students in the undergraduate laboratories has been placed on a somewhat more independent basis for the purpose of securing greater originality and initiative. Practically all students are dealt with by means of a conference system, a feature of which involves the keeping of continuous notebooks of experiments for the entire term. This results in closer contact between students and instructors and in a better correlation of the individual experiments.

As has been the custom for several years, a series of colloquia is being held by men invited from industry in order to show the relationship of the scientific aspects of the curriculum to actual engineering work. This year these colloquia are being led by engineers from the Westinghouse Electric and Manufacturing Company, the General Electric Company, the Weston Electrical Instrument Corporation, and the Bell Telephone Laboratories.



GENERAL VIEW OF THE NETWORK ANALYZER

Showing the layout of the four sections, and the accompanying instrument tables. (A portion of the bridge used for the original calibration shows at the right.)

THE research work of the Electrical Engineering Department is carried on primarily for its educational value, but many developments turn out to be of great practical importance as well. Some of the outstanding ones are worthy of mention.

The most important recent development is the alternating current network analyzer. This is a device for determining voltage, current, power, and phase angle under circumstances of normal system operation, short-circuit analysis, or stability studies. The apparatus (located in the electrical engineering research laboratory) was built in coöperation with the General Electric Company, and while primarily for educational purposes, is available to practicing engineers for the solution of their problems.

Two new integraphs are in the process of development. One of these is an outgrowth of the old integraph which has attracted such wide atten-

(*Continued on page 118*)

A world-wide market place

Eighty-five per cent of the world's telephones can be reached from any telephone of the Bell System. This includes those of Canada, Cuba, Mexico, and—by the new radio-telephone link spanning the Atlantic—most of the countries of Europe.

Already many American business men are using this service to expedite the transaction of foreign business and are finding it quick, convenient and profitable.

The future possibility of talking directly with almost anyone in the world who has access to a telephone is enough to stimulate any man's thinking—not only from an engineering standpoint, but because of its significance to American industry.

BELL SYSTEM

A nation-wide system of inter-connecting telephones

"OUR PIONEERING WORK HAS JUST BEGUN"

The Honors Group Plan

(*Continued from page 85*)

of Technology participate in the destruction of property and otherwise behave ungentlemanly in public, it is hardly reasonable to assume that while each of these students no doubt was a gentleman and a scholar in Middletown High School and lived in a home where ill manners were effectively curbed, somehow the Massachusetts Institute of Technology has done strange things to him. But even if this were true the situation would not be without an encouraging aspect, for if the workings of such a remarkable process could be fathomed it might be possible to work it backwards and thus produce in four years from even the most raw material, ripe scholars of a most advanced sort.

The hope of achieving the aims of education resides fundamentally in the quality of students and staff and in the existence of cordial relations of coöperation between them. Just as natural energy is more to be respected than the mechanical contrivances for its utilization, so the mechanics of the educational processes are of somewhat secondary importance. However, the steam turbine or the uniflow engine is vastly more effective than Watt's atmospheric engine; present-day water-wheels are much superior to the paddle-wheel affairs of the ancients. And so in education it is desirable to use educational schemes which are most effective, in order to derive the maximum results from the potentialities.

The series of subjects, Principles of Electrical Engineering, and the Electrical Engineering Laboratories, form the trunk of the courses in electrical engineering. In the former the theory is propounded and explained, and illustrated by means of problems; in the latter it is further illustrated, and verified by means of experiments.

In the subjects, Principles of Electrical Engineering, which extend from the middle of the sophomore year to the end of the senior year, fundamental laws of the electric, dielectric and magnetic circuits, principles of direct-current machinery, alternating currents, alternating-current machinery, and electric power transmission and distribution are studied. In these subjects the emphasis is upon principles and not upon details of design or practice. Instruction is given by means of two to four classes per week, weekly problem sections, practice problems, and term examinations.

In the classroom work, recognition is made of the fact that all men do not learn with equal ease or speed. At the beginning of the second term of the sophomore year the students in Principles of Electrical Engineering are divided into sections of about twenty men or less primarily in accordance with their previous records in Mathematics and Physics. Ordinarily, there is a fast, an intermediate, and a slow section, or several sets of such sections, depending upon the number of students. After this initial selection, the students are watched closely as to performance in classroom discussion and in the weekly problem. Except for clear-cut mistakes in sectioning, no changes are made until about five weeks have passed, but throughout the term doubtful cases are discussed in conference by the teaching staff for the subject, and whenever it becomes evident that a student differs greatly from the average mental speed of his section he is moved either to a faster or slower section as seems advisable. This process continues throughout all the following terms of Principles of Electrical Engineering, but changes become fewer and fewer as time goes on.

The scope of work in all sections is the same, but the method of treatment is quite different. In the slow section the textbook is adhered to rather closely and explained; there is considerable of drill and repetition. A large number of illustrative problems are used. Mathematical work is supplemented by the use of descriptive matter for the purpose of creating clearer mental pictures. In the fast section the textbook is not touched upon very much by the instructor except in so far as special questions pertaining thereto are raised. It is assumed that on the whole the students in the fast section are able to master the textbook without much aid and have time to spare. In this section, therefore, the work is more highly mathematical; collateral sources of information are suggested to the students and are used by the instructor; problems of a complexity more nearly that encountered in engineering work are proposed in class or are assigned to certain students for solution and discussion. The object is to deepen the understanding and strengthen the grasp of the subject, rather than to increase the range of the subject matter. In the intermediate section the method of treatment is intermediate between that for the slow and that for the fast sections.

Assignment to or transfer to a slow section need in no way be considered as a stigma. The system is designed to approximate the needs of individual students and shows consideration of that fact that men of nearly the same age learn at different rates and in different ways. It is no prediction that a man who now is mentally slow will always be so. Indeed it may be that some who find themselves leaders in the profession some years hence will owe at least a small part of that success to the fact that when they had not yet reached the mental agility later acquired they were handled in accordance with their needs at the time, and were not confused and discouraged by instruction which went over their heads. Some students develop their mental processes very slowly and laboriously for a time until a point seems to be reached when vista after vista unfolds itself and progress is made with unexpected ease and speed. Of course, in the case of men who are in a slow section because they fail to exert themselves there is definite cause for concern, because they are not taking advantage of the opportunities before them. Furthermore, each student should endeavor constantly to improve his technique of learning; it should be the ambition of students in the slower

(*Continued on page 102*)

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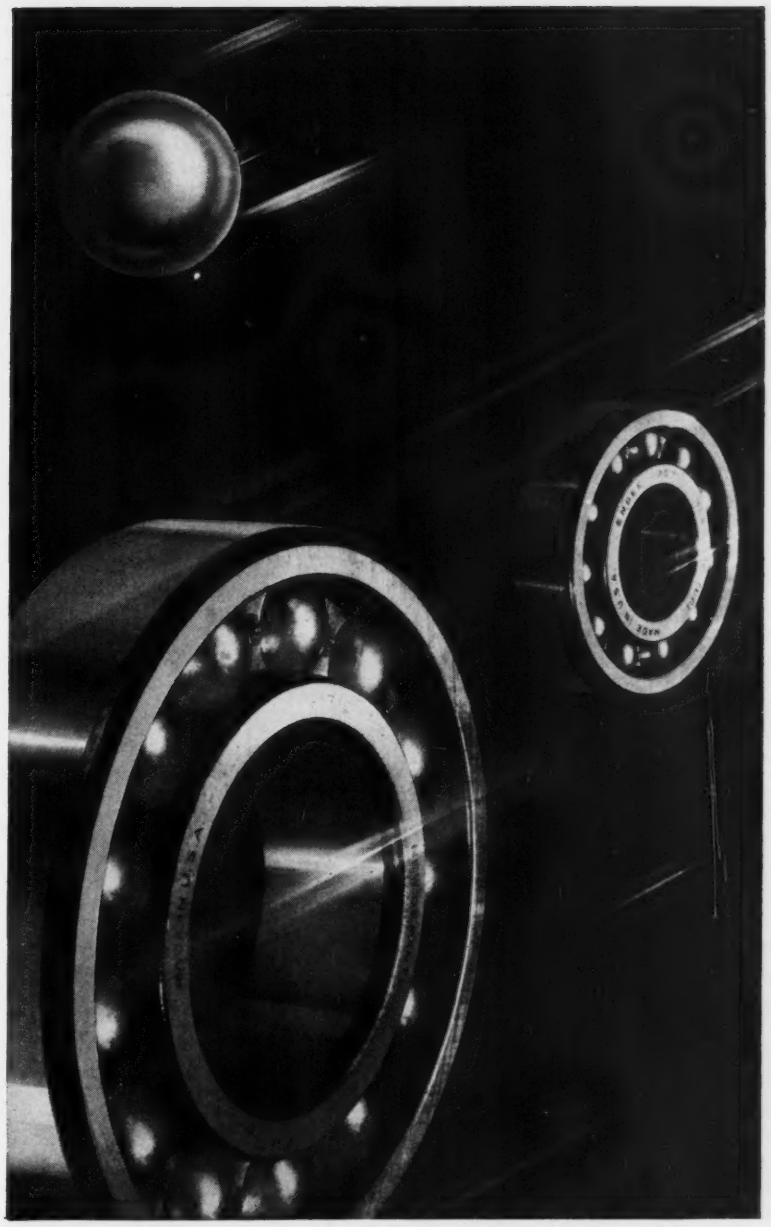

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NEW DEPARTURE MANUFACTURING COMPANY BRISTOL CONN.

The Honors Group Plan

(*Continued from page 100*)

sections to fit themselves for transfer to a faster one, and those in the fast sections should be jealous of their positions, though if conditions should become such that all sections could be run as so-called fast sections the staff would be first to rejoice.

There has been a theory afloat amongst some of the staff, Professor Lansil for one, that due to the retroactive nature of the problem sections and to the inherent property of dependent sequence which characterizes the science, a successful student should be distinguished by a series of problem section records having a general upward trend and an unsuccessful student should be distinguished by a series of records having a general downward trend. Of course, in the case of students who reach the height of perfection immediately and stay there no upward tendency can be detected from the records to clinch the view that these students really have been successful, and so they have to be given honors without further analysis. However, most of the present class have been shrewd enough to avoid this embarrassment, for the problem section records for the first few weeks afford some most gratifying possibilities for positive slopes approaching infinity.

Figure 1 is a plot showing these curves for each section in the junior year direct-current machinery last term. The base line for each curve is at 6, the nominal passing grade when the maximum possible is 10. These curves, it will be noted, largely substantiate the theory. Curious exceptions are the points marked "x" on each curve. These represent the results for the last problem section, which was (in accordance with a recent custom) a rather comprehensive review of the term's work by means of questions of a qualitative rather than of a quantitative sort. It was predicted that those who had mastered the principles most thoroughly (as shown by their rising slopes) would turn in the best papers on this test, while those whose slopes were negative would do very poorly, but almost the contrary proved to be the case. Of course the explanation given is that those who had risen to affluence could not stand the prosperity and relaxed their efforts, while those who had been courting disaster recognized the need for a ninth inning rally. But curiously enough the corresponding plots for the senior year alternating-current machinery showed no such discrepancy for the last problem section (of similar character) and so with a perfectly good explanation available there seemed to be no place to put it. But then, of course, by the time men become seniors they should be free from the vanities of accomplishment and immune to the lure of relaxed effort, so thus the theory is returned to full esteem!

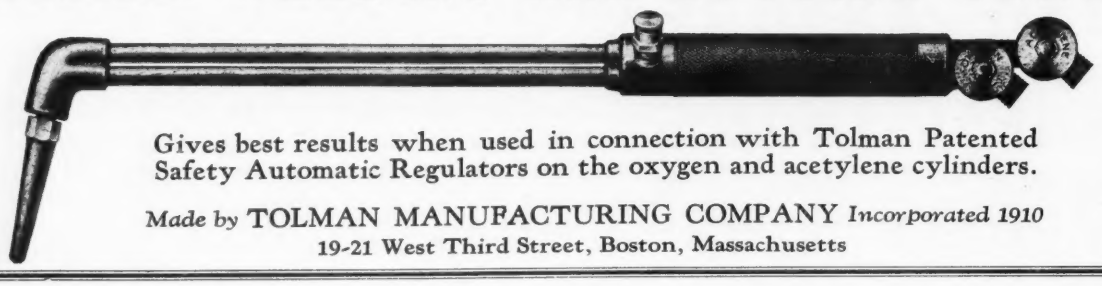
An extension of the plan for sectioning for mental speed is the Honors Group Plan, though this is more comprehensive, in that it affects all subjects of instruction taken by students in electrical engineering in the junior and senior years whether given by this department or by other departments. The aim is to instill a spirit of self-reliance, resourcefulness, and intellectual courage in students of exceptional promise by creating an independent atmosphere of work and a flexibility of requirements designed to meet individual needs.

The most severe criticism which has been made of education in this country in recent years is that it has been planned to meet the needs of the average student and makes little or no adequate provision for students of unusual brilliance. Thus it tends to level down as well as up. But the spirit of democracy has run out of bounds when it endeavors to keep men intellectually equal. While there are many excellent reasons for the education of the masses, and such educational efforts ought to be continued, it should be borne in mind that most of the really great advances in civilization have been due to the work of a very few gifted men. Arthur D. Little estimates the number of people in the whole world who by their creative powers contribute to the advancement of science to be one hundred thousand at the very most. This number of course includes many stars of second order and less, the number of stars of first magnitude probably being no greater than the number of fingers of the hands. The initiative of such persons is unduly hampered and the interest stifled by the rigidity and routine of ordinary schooling. It is notable that many such men were sheltered from conventional education due to ill health, poverty, or other misfortune. However, in the case of the old universities of England, Oxford and Cambridge, where for generations especial attention has been given to the students of unusual brilliance, many of the graduates have become the leading statesmen and scientists of their times. Such names as Pitt, Gladstone, Balfour, Newton, Kelvin, Maxwell and others can be called to mind. But, even so, American educators are apt to distrust processes which have been used for long periods without change, because of a suspicion that this long period of apparent stability may indicate not that the ultimate has been attained, but merely that attempts at improvement have been abandoned, or perhaps that it is only the outward form and not the heart of the process which now persists. And there are differences of tradition, temperament, and environment existing between the people of this country and England which make the transplanting of the English method in form undesirable. Therefore American educators have sought only the fundamental principle which underlies the success of the English method. This principle is believed to be found in the sense of responsibility, spirit of self-reliance, and initiative which follows from giving chosen students opportunity to develop these qualities.

The workings of the Oxford system have been explained rather humorously by Stephen Leacock in "Oxford as I see it":

(*Continued on page 104*)

TOLMAN WELDING AND CUTTING TORCH



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University of Wisconsin '26
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Wrestling 2 years
Honorary Society
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30 East 42nd Street UCC New York, N. Y.

The Honors Group Plan

(*Continued from page 102*)

"Oxford trains scholars of the real type better than any other place in the world. Its methods are antiquated. It despises science. It has professors who never teach and students who never learn. It has no order, no arrangement, no system. Its curriculum is unintelligible. . . . Oxford is much smaller in numbers, for example, than the State University of Minnesota, and is much poorer. . . . To mention Oxford beside the 26,000 students of Columbia University sounds ridiculous. In point of money the $30,000,000 endowment of the University of Chicago . . . seem[s] to leave Oxford nowhere. Yet the peculiar thing is that it is not nowhere. By some queer process of its own it seems to get there every time.

"The effect of the comparison is heightened by the peculiar position occupied at Oxford by the Professor's lectures. In the colleges of Canada and the United States the lectures are supposed to be a really necessary and useful part of the student's training. Again and again I have heard the graduates of my own college assert that they had got as much, or nearly as much, out of the lectures at college as out of athletics or the Greek-letter society or the Banjo and Mandolin Club. In short, with us the lectures form a real part of the college life. At Oxford it is not so. The lectures, I understand, are given and may even be taken. But they are quite worthless and are not supposed to have anything much to do with the development of the student's mind. . . .

"It appears further that the professors themselves are not keen on their lectures. If the lectures are called for they give them; if not, the professor's feelings are not hurt. He merely waits and rests his brain until some later year the students call for his lectures. There are men at Oxford who have rested their brains in this way for over thirty years; the accumulated brain power thus dammed up is said to be colossal.

"I understand that the key to this mystery is found in the operations of the person called the tutor. It is from him, or rather with him, that the students learn all that they know; one and all are agreed on that. Yet it is a little odd to know just how he does it. 'We go over to his rooms' said one student, 'and he just lights a pipe and talks to us.' 'We sit around with him,' said another, 'and he simply smokes and goes over our lessons with us.' From this and other evidence I gather that what an Oxford tutor does is to get a little group of students together and smoke at them. Men who have been systematically smoked at for four years turn into ripe scholars. . . . A well smoked man speaks and writes English with a grace that can be acquired in no other way. . . .

"In what I have said above I seem to have been directing criticism against the Oxford professors as such; but I have no intention of doing so. For the Oxford professor and his whole manner of being I have nothing but profound respect. Here indeed is the greatest difference between the modern up-to-date American idea of a professor and the English type. . . . A university professor in America is now a busy, hustling person, approximating as closely to the business man as he can manage to do. . . .

"The American professor deals with his students according to his lights. It is his business to chase them over a prescribed ground at a prescribed pace, like a flock of sheep. They all go humping together over the hurdles, with the professor chasing them with a set of 'tests' and 'recitations,' 'marks' and 'attendances,' the whole apparatus obviously copied from the time clock of the business man's factory. . . . It puts a premium on dullness and a penalty on genius. It circumscribes that attitude of mind which is the spirit of real learning.

"The whole system at Oxford is such as to put a premium on genius and to let mediocrity and dullness go their way. On the dull student Oxford, after a proper lapse of time, confers a degree which means nothing more than that he lived and breathed at Oxford and kept out of jail. This for many students is as much as society can expect. But for the gifted student Oxford offers great opportunities. There is no question of hanging back until the last sheep has jumped over the fence. . . . [Each student] may move forward as fast as he likes, following the bent of his genius. If he has in him any ability beyond that of the common herd, his tutor, interested in his studies, will smoke at him until he kindles him into flame. . . . The American professor has no time to be interested in a clever student. The student of genius merely means to him a student who gives him no trouble, who passes all his 'tests' and is present at all his 'recitations'. . . . The everlasting principle of equality has inserted itself in a place where it has no right to be and where irregularity is the breath of life."

In contrast to this it is interesting to note the closing portion of a letter printed in the Open Forum of *The Tech* in reply to an editorial which

(*Continued on page 106*)

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STANDARD OIL COMPANY OF NEW YORK
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The Honors Group Plan

(*Continued from page 104*)

precipitated considerable of the discussion referred to at the beginning by pointing to certain alleged advantages of European education. It read:

"Lastly this fellow deliberately champions the European policy of cultivation of the tenth and neglect of the nine-tenths. The United States have always stood for the masses, and the United States have succeeded. Yes, gentle writer, we remain satisfied."

Fears of this sort are sheer nonsense. The introduction of educational processes designed to meet the needs of the exceptional does not mean the withdrawal of processes found to be suited to the average. But to insist that the same educational process must serve for all, or that the same educational opportunity is due to all by right is to ignore the fact that all men are created dependent and unequal. It seems fundamental that educational processes can be relied upon for effectiveness only in so far as they take into account the circumstances of those to be educated.

In the Honors Group Plan of this Department, students are chosen for the Honors Group of their class at the end of the sophomore year from those who apply for the privileges, largely on the basis of the excellence of their previous records, particularly in Mathematics, Physics, Chemistry, and Applied Mechanics, and the work in Principles of Electrical Engineering up until the time of selection. The opinions of various members of the staff with regard to the intellectual capacity, ambition, resourcefulness, sense of responsibility, definiteness of purpose, and power for sustained effort also are important elements in the selection.

The students in the Honors Groups are privileged to attend the class exercises of the regular subjects or not, as they individually please. Of the practice problems assigned to the classes, the honors students are privileged to work out such numbers as they individually please, but each is encouraged to spend time over the details of only those that are new to him, thus avoiding loss of time by unnecessary repetition. All are expected to do the work of the regular weekly electrical engineering problem section and to attend all previously announced written quizzes and all their subjects, and are expected to pass with distinction the usual term examinations. At the end of the senior year the honors students are given a comprehensive examination covering the field of electrical engineering and its collaterals, in order to obtain for them and for the staff an indication of their general grasp upon the field of study as a whole and the relationships of its parts. In the past this examination has been voluntary and has carried no weight in connection with graduation. However, the interest of the honors students has been so great and the results so satisfactory that it has been decided to introduce the comprehensive examination as a requirement for honors students this spring, and to waive certain term examinations in its favor.

The laboratory work of each term which usually consists of a series of specific assignments, consists for honors students in the Electrical Engineering Laboratories of a general assignment relating to the principles of construction and the characteristics of the circuits, instruments, and machinery

(*Continued on page 108*

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The Honors Group Plan

(*Continued from page 106*)

treated during the terms with specific problems and method of work thereon determined largely by the interest of each student. The usual laboratory reports are omitted, and the report for each student consists of a notebook containing an outline of his plan for the term, the record of his various investigations, his comments, and a brief summing up toward the end of the term of his accomplishments and progress during the term. Honors students who become interested in a particular investigation even as early as the junior year, that may be developed into a suitable thesis project, may substitute this for a larger part of the usual electrical engineering laboratory work.

For the purpose of assisting in the orderliness of progress, overcoming of unusual difficulties, and stimulation to independent and original work there are available for each of the Honors Groups a general counselor from the staff of the Department and special conferees from the staffs of other departments in which the honors students take subjects. It is expected that the honors students will work mostly under the direct guidance of these men rather than by attending set exercises, and that advantage will be taken of the opportunity which freedom from fixed schedules provides for considerable reading and study related to the subjects of the curriculum. Substitution of subjects in the curriculum is permitted in order to accommodate particular tastes and interests of individual students, provided that these substitutions do not carry the student too far afield.

The features outlined necessitate each honors student's whole-hearted acceptance of the responsibility of effectively planning and carrying out his method of study, with the counsel and advice of his counselor and conferees. Such individual acceptance of responsibility is fundamental to the success of the Honors Group Plan. Each honors student is his own taskmaster, for the external compulsion and discipline has been largely removed and must be replaced by an internal discipline.

This lesson of self-administration is a difficult but most valuable one to learn. In fact, critics of the plan as outlined would maintain that young men who have turned twenty are too irresponsible and boyish to expect them to have judgment sufficient to run their own affairs, and that to do so is to court disaster. But, as James Truslow Adams says in his essay, "Is America Young?"

"There is a time to stop telling a boy he is young. There comes a time when we must tell him to be a man, to do a man's work and try to think a man's thoughts. If we keep on coddling him and telling him he is a child of whom nothing is expected, we are not likely ever to make a man of him."

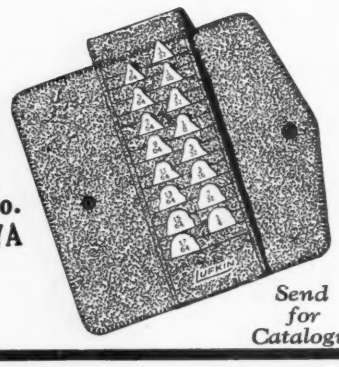
In the opinion of many, this time should come long before it ordinarily does in American education. William E. Wickenden, director of an investigation of engineering education conducted by the Society for the Promotion of Engineering Education says in one of his reports:

"We have to compensate for the results of a scheme of secondary education . . . comparatively flabby and superficial. . . . We shall lag in the higher stages of technical education unless we can get our abler students to assume much more initiative. Our whole set-up tends to become a scheme to *give* students an education. Too often our colleges are highly elaborate schoolhouses, our students are overgrown schoolboys, and our professors glorified school masters. . . ."

The author has been listening to Professor Weiner's general study, History of Philosophy. After several weeks of most interesting discussion had gone by, a young neighbor remarked that he wished to know how the professor was going to "mark" in the course: no attendance had been taken and apparently no other tangible data had been gathered to date. True, a book containing parts of the writings of a number of philosophers had been recommended, but it seemed to include some that were not "required." A little questioning brought out the fact that this student had been accustomed to classes where the taking of attendance was the opening rite, and where the requirements had a definiteness which enabled one to aim directly at them without the worry of feeling it wise to provide a rather indefinite factor of safety. In fact, in one class, he said, the law laid down was that those who were present at every exercise and kept awake would surely pass. This, of course, is an exaggeration, but serves to illustrate the attitude of which Mr. Wickenden speaks.

Now much of the spirit which caused the inauguration of the Honors Group Plan in this Department five years ago has filtered into the whole scheme of its undergraduate instruction. Detailed rules and requirements gradually have been lessened as it has been recognized more and more that while young men may not have judgment of a very high order, such cannot be expected to be developed by the restriction of opportunity for exercising it. In this discussion an attempt has been made to show that while the Department expects that the work of all students who seek the degree of the Institute will be of high quality, recognition has been made of the intellectual differences which exist among men, and provision has been made to treat men as individuals, in so far as it is practicable. It is felt that by the division of the students into small groups, the advantage of intimacy of contact between students and instructors claimed by small colleges

(*Continued on page 112*)



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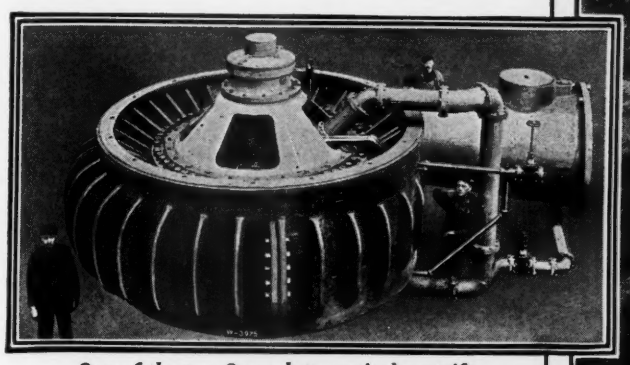

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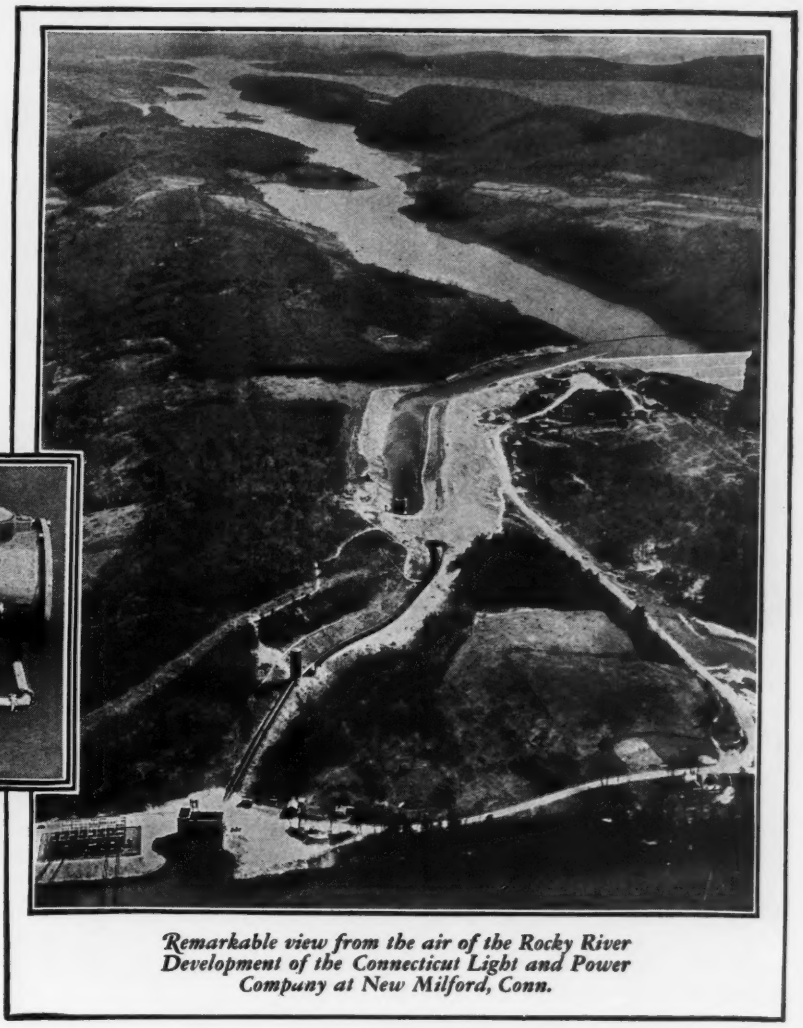

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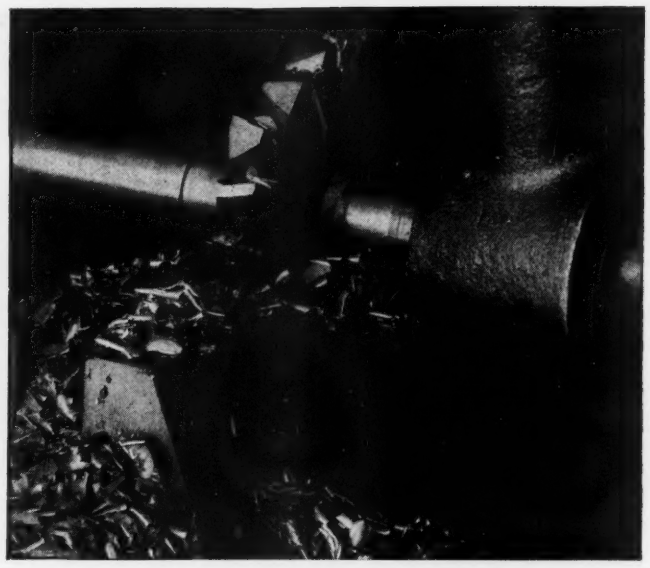

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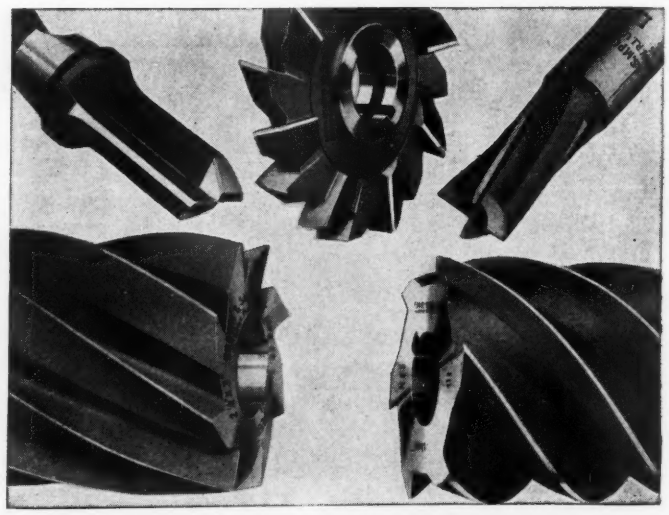

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National Equipment Corporation *Milwaukee Wisconsin*

The Honors Group Plan

(*Continued from page 108*)

is gained, without the attendant loss due to smallness of the staff. In this Department, each student can expect to have fairly close association with a half dozen or more members of staff during his undergraduate life, and in addition have access to many others of the staffs of this and other departments for the discussion of particular problems. It is the hope of the staff that the students of this class soon will learn to make use of this privilege as one of the most valuable aids to self-education, which after all is the only kind of education that there is. As Walt Whitman has said:

"Wisdom is not finally tested in schools,
Wisdom cannot be pass'd from one having it to another not having it,
Wisdom is of the soul, is not susceptible of proof, is its own proof,
Applies to all stages and objects and qualities and is content,
Is the certainty of the reality and immortality of things, and the excellence of things;
Something there is in the float of the sight of things that provokes it out of the soul."

The Engineer and the Stock Market

(*Continued from page 91*)

the self-winding ticker was not very greatly in excess of 300 characters per minute. Design proceeded along the lines of well known principles, through experience with other printing telegraph apparatus and systems but with the added problem of increasing the speed considerably beyond that which any printer for quotation service had heretofore operated. The new high speed ticker is, therefore, a cumulative result of developments and improvements in design rather than any startling invention or adoption of new principles. The final design was effected only after construction of a large number of laboratory models and extensive tests and observations of their operation with successive improvements in features of each design. The final instrument operates at 500 characters per minute or nearly twice the speed of the old step-by-step tickers while requiring the use of only one main line wire instead of two.

There are three limitations to increasing the speed of a ticker operated on the step-by-step principle: first, a considerable amount of power must be supplied to the ticker over the telegraph signal wires; second, a considerable amount of time is required to rotate the typewheel from one printing position to another as the alternating current impulses which control this rotation cannot be sent at a speed greater than ordinary automatic telegraph signalling speed; third, two signal wires are required to operate the ticker.

The new high speed ticker development, therefore, took place along the lines of reducing the operation to one wire control; reducing the amount of signalling current required; furnishing a local source of power at the ticker; and a change of code which would not require so many transmitted impulses to control the position of the typewheel.

THE high speed ticker operates on a start-stop principle similar to Simplex printers which are coming into general telegraph use. A local source of power is supplied by having a small electric motor furnish the driving means for rotating all of the moving elements in the ticker and perform the operations of shifting, printing, rotating the typewheel or other mechanical movements.

Instead of the step-by-step code of

(*Continued on page 116*)

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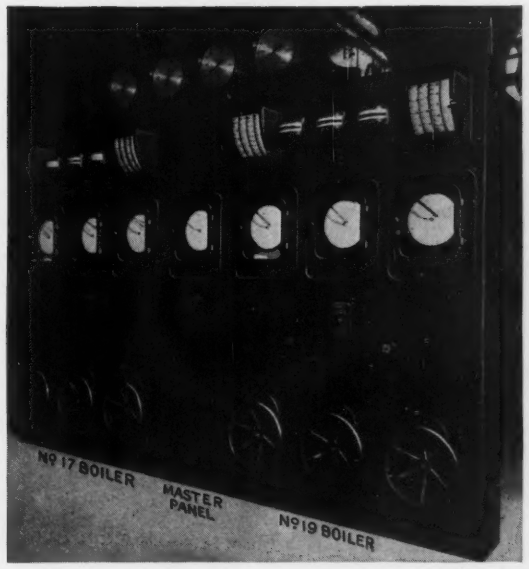

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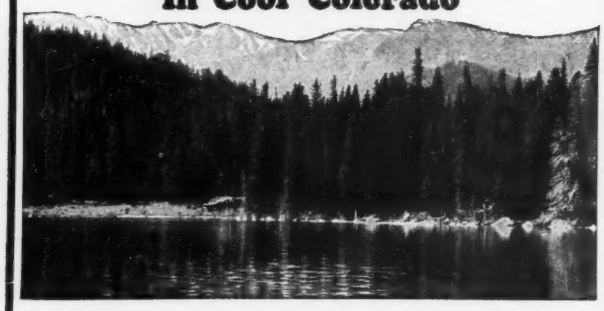

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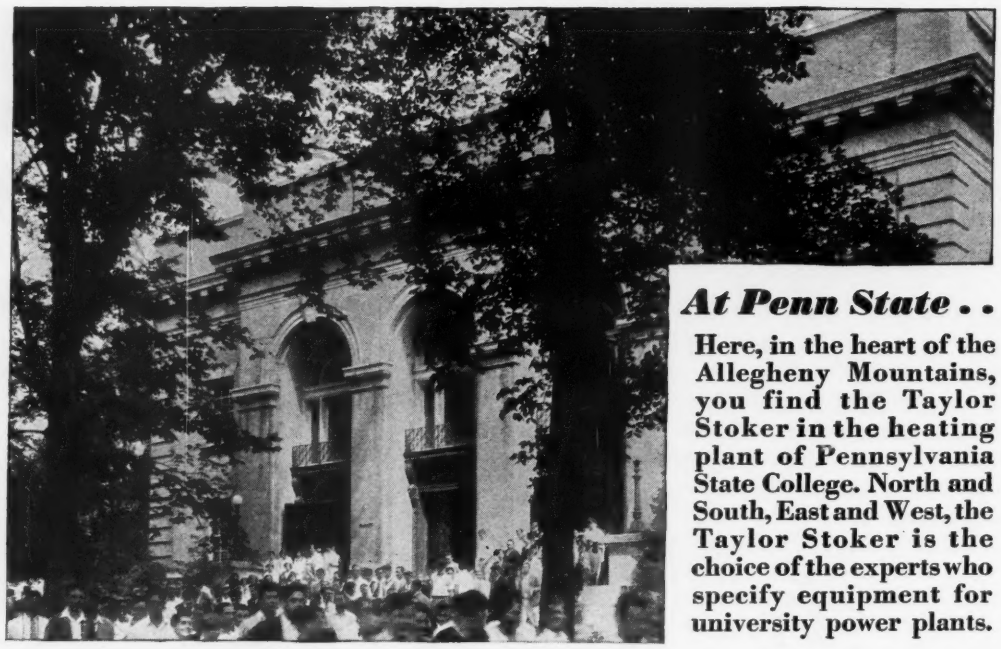

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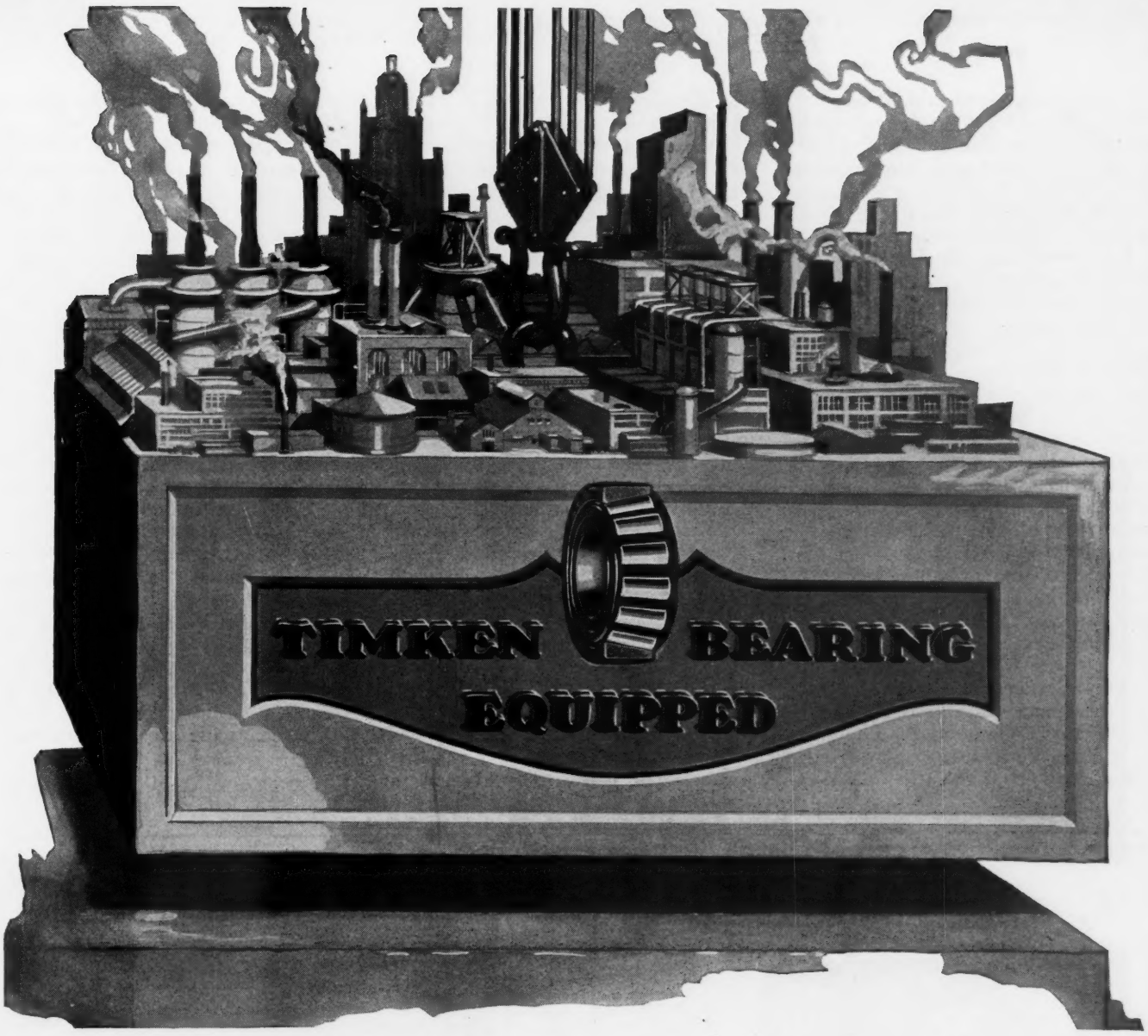

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TIMKEN *Tapered Roller* **BEARINGS**

The Engineer and the Stock Market

(*Continued from page 112*)

the previous tickers which averaged sixteen current units for each character printed, a permutation code is used, which, with start and stop impulses added for each character, makes a total of eight unit current impulses for each character. There is only one magnet in the new ticker, its coil being connected directly in the main line signal circuit. Impulses coming over the signal wire change the position of the armature of this relay but are not required to do any other work. The position of the relay armature merely controls the selecting and operating functions of the ticker and the motor performs all the work.

Normally, when no signalling impulses are being received all of the mechanism of the ticker except the motor itself and its pinion is at rest. The accompanying photograph (Figure 3) shows a certain portion of the mechanism of the high speed ticker. A motor located at the back of the ticker drives two shafts, one directly above the other. The lower shaft carries the typewheel and is rotated by means of a friction clutch. The upper shaft is also rotated through a friction clutch and carries the selection mechanism.

The upper friction clutch is released when the start impulse is received on the main line magnet and allows the selection mechanism to start rotating. This rotates exactly in phase with the incoming selection impulses so that it is in a certain definite position when each of the arriving selection impulses actuate the main line magnet. The polarity of the signal impulses is changed depending on whether any particular signal is marking or spacing. These in turn, through the selecting cam drum, set little storage fingers in a certain position. All of the selecting units of one character are stored thus before any attempt at positioning the typewheel is made.

Immediately after all of the selecting impulses of one character are received a transfer action takes place, which transfers all of these mechanically stored selection impulses into a stop disc unit. These set the code plates or discs in either marking or spacing position and these in turn allow a certain one of 30 stop pins to fall into a selecting slot. The typewheel then starts rotating. This carries on the shaft with it a typewheel stop arm which strikes against the selected stop pin and causes the typewheel, therefore, to come to a stop at this particular selected position.

With the typewheel thus put in position, certain operating functions take place through cam operated mechanism driven by the electric motor. The printing hammers are forced upward by this operation, pressing the paper tape against the typewheel and printing the selected character. Immediately following this the tape is stepped ahead. The shift from figures to letters takes place at the same time that the selecting code discs are being set in position. During the time that the typewheel is rotating to its new selected position and while the printing and tape feeding operations are taking place, the selection impulses for the next following character are being received by the main line magnet and are being stored in the selection mechanism. This is one important feature in the design which permits of higher speed, namely, the fact that one character is really stored in the ticker mechanism and is being printed while the selection impulses for the next following character are being received and stored.

(*Continued on page 118*)

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Works Rite
Wears Rite

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Length over all	7½-inches
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Loaded Speed	1200 RPM
Weight	4½ lbs.

Locking device supplied for continuous running if desired $1.00 extra

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James Clark, Jr. Electric Company

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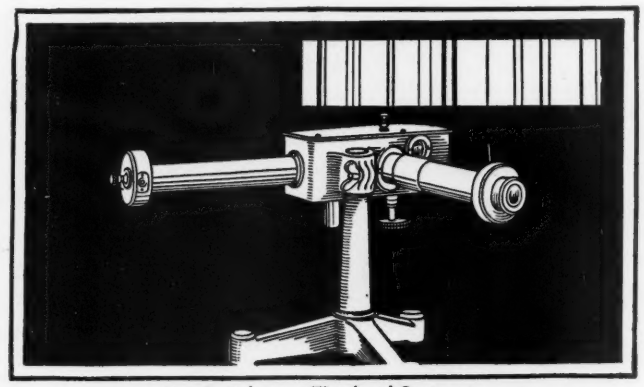

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CAST IRON PIPE

Sand Spun or Sand Cast for Gas and Water

FITTINGS

Gate Valves and Boxes

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Gas Machinery

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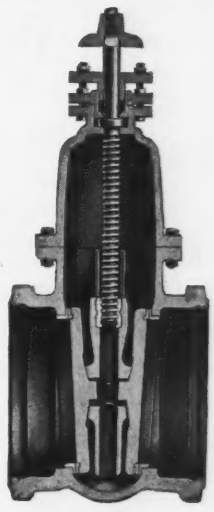
We extend an invitation to all interested students to visit our extensive plant to observe the manufacture of "MATHEWS" Hydrants, and our other products.



CAST CENTRIFUGALLY IN SAND MOLDS

R. D. WOOD & COMPANY

Engineers, Iron Founders, Machinists

PHILADELPHIA, PENNSYLVANIA

The Engineer and the Stock Market

(*Continued from page 116*)

Continuity of service is an important feature in rendering satisfactory ticker service. Elaborate reserve central office equipment is set up so that in case of failure of the regular operating equipment the reserve apparatus can be switched into use in a few seconds' time and service continued without appreciable delay. An elaborate schedule of fallback main line wire maintenance is set up so that in case of failure of the wire between two cities for any reason whatever, a spare or reserve wire is immediately thrown into the transmitting and receiving sets and the service is restored with but a loss of a few seconds. Accuracy of transmission and reception is also of vital importance. The transmitting keyboard operators are of the very highest type and will operate for several days at a time without making any errors.

In all respects ticker service has always to be at the peak of efficiency in accuracy, continuity and speed of service. All central office and subscribers' equipment is designed with this in view and the operating and maintenance forces keep these factors at all times paramount.

Departmental Notes

(*Continued from page 98*)

tion. The old integraph, which operates on electro-mechanical principles involving the direct-current watthour meter and the Kelvin Wheel is capable of giving a precision of about one per cent. Its offspring will operate upon mechanical principles based on the Kelvin Wheel. Each unit is expected to give a precision of one-tenth of one per cent, and the over-all precision will depend upon the number of units used.

The other new integraph, practically completed but still undergoing refinement operates upon photo-electric principles. It uses a photo-electric cell to integrate the effect of light passed through openings in screens cut to the shapes of the curves of the functions involved and moved across a light source.

Investigation of the properties of insulating materials is being continued. The particular phase of the investigation at present is the study of the intermediate region of breakdown in insulating papers. Also, a study is being made in coöperation with the National Electric Light Association in order to devise a standard test for measuring the thermal conductance of impregnated paper insulated cables.

In the machine transients laboratory the most important study is that of the phenomenon of self-sustained hunting in synchronous motors. An analysis is being made of the factors contributing to this condition in hope of determining the relationships among them so that such objectionable performance can be predicted.

A number of problems relating to radio communication and aviation are being worked out by members of the Electrical Engineering Department staff at the Round Hill Experiment Station located near South Dartmouth. Tests have been made to see whether it is more advantageous to use light of any particular color for the penetration of fog. In general there seems to be little advantage of one color over another, though red sometimes gives greater contrast. Within the last six to eight months much work has been done with the aid of a dirigible in making measurements of field strengths. From these measurements careful plotting of the shapes of field strength patterns both above and below ground has been made possible. Other investigations are being made to improve the theory relating to antenna feeding systems, for the present theory has been found to be inadequate.

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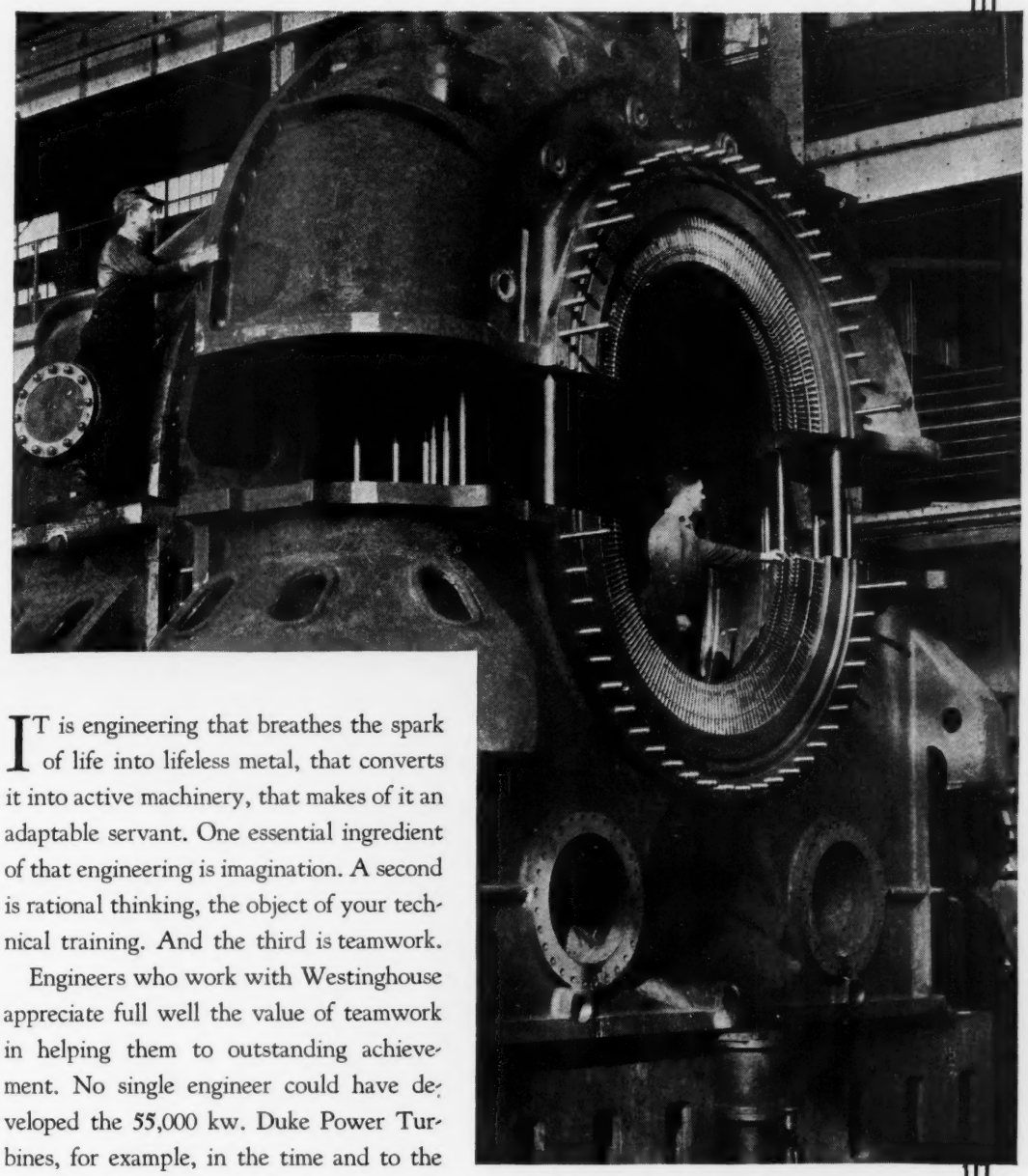
DEAD METAL LEAPS TO LIFE

at the hands of Westinghouse engineers



The 55,000 kw. turbine-generator units that Westinghouse built for the River Bend station of Duke Power Company are the largest in the South.

IT is engineering that breathes the spark of life into lifeless metal, that converts it into active machinery, that makes of it an adaptable servant. One essential ingredient of that engineering is imagination. A second is rational thinking, the object of your technical training. And the third is teamwork.

Engineers who work with Westinghouse appreciate full well the value of teamwork in helping them to outstanding achievement. No single engineer could have developed the 55,000 kw. Duke Power Turbines, for example, in the time and to the degree of perfection that the Westinghouse organization did.

Here teamwork extended back to the date when George Westinghouse brought the steam turbine to America. It included men who have made life studies of vibration, of blade design, of the effects of superheated steam on metals. It embraced the foundrymen who made the huge castings required, and the packers who have mastered the science of shipping giant machinery. And it took in also the business men who create a market for such machinery and who cement together the many-fold activities of the Westinghouse institution.

Westinghouse

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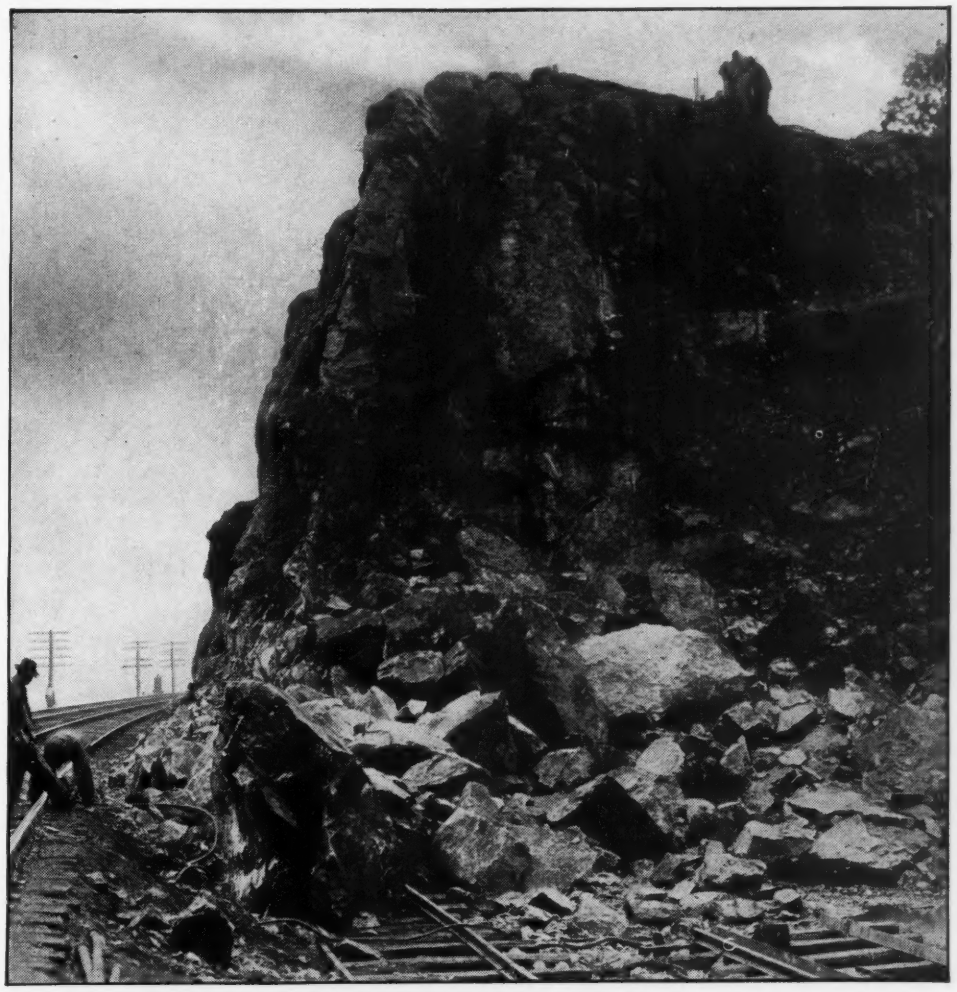

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